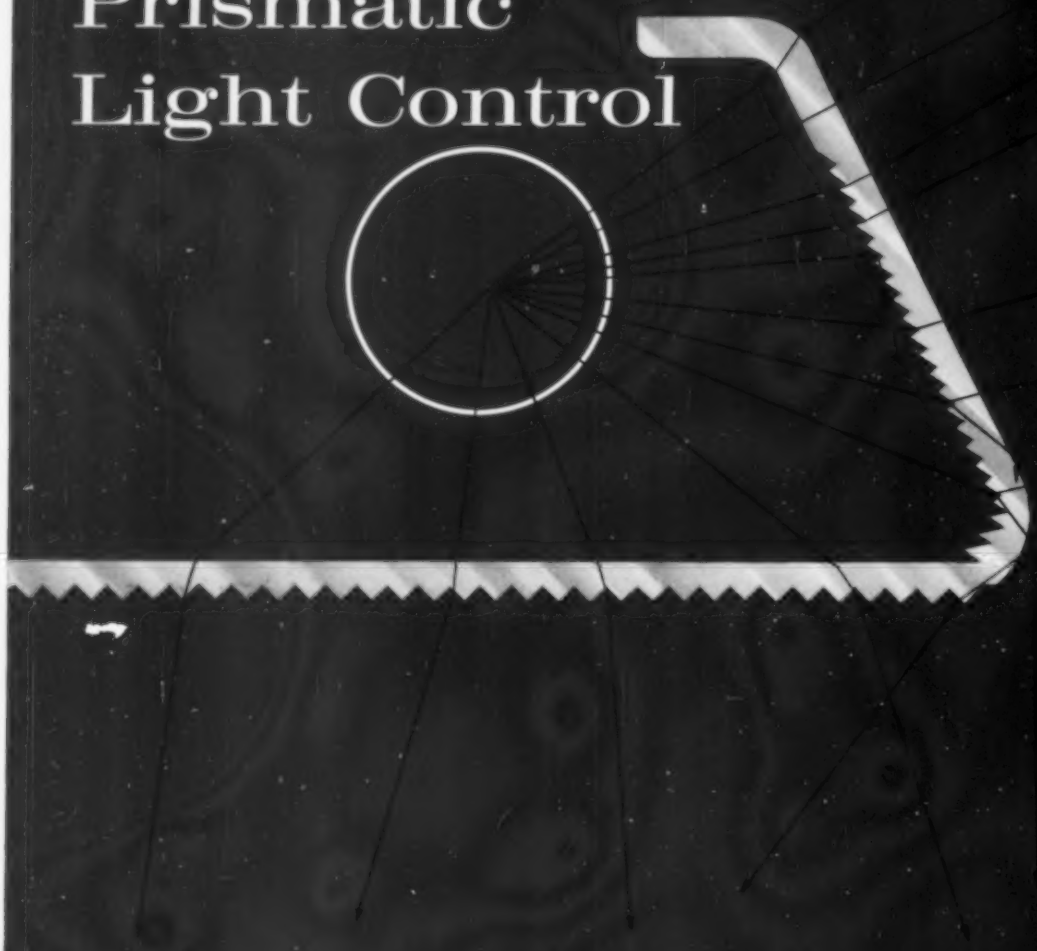
AUGUST 1961

ie

ILLUMINATING ENGINEERING

Journal of the
ILLUMINATING ENGINEERING SOCIETY

Prismatic Light Control



THE WAKEFIELD

PHOTOMETRIC

gives prism-controlled fluorescent light that is directed to the working area with minimum glare. Uses acrylic refractor you can afford.

WAKEFIELD CORPORATION

ELECTRICAL PRODUCTS GROUP
Wakefield Lighting Division — Vermilion, Ohio
Wakefield Lighting Limited — London, Ontario

Art Metal Lighting Division — Cleveland 3, Ohio
1814 East 40th St.
Sta-Warm Electric Company — Ravenna, Ohio

ADVAN guard®

AUTOMATIC RE-SETTING THERMOSTAT

gives fluorescent lamp ballasts..... a 2nd chance

prevents

PREMATURE DESTRUCTION

from:

- **Abnormal Operating Temperatures**
- **Incorrect Voltage Supply**
- **Excessive Current**
- **Internal Short Circuiting**
- **Inadequate Lamp Maintenance**
- **Lamp Rectification**
- **Improper Fixture Application**

Protects against end-of-life hazards ... eliminates the need for individual fusing.

Only ADVAN-guard®, a thermally actuated protective thermostat sealed in the ballast housing, gives fluorescent lamp ballasts a "Second Chance." It automatically "trips-out" whenever the ballast operates at abnormal temperatures from any internal or external cause. Unlike other protective devices which permit premature ballast destruction by cutting the ballast out of the line only after it has been destroyed, ADVAN-guard® cuts out before heat can cause premature destruction, resets automatically when the trouble has been corrected and permits the ballast to resume normal operation. Insist on ADVAN-guard® equipped fluorescent lamp ballasts for safety and longer life.

"The Heart of the Lighting Industry"

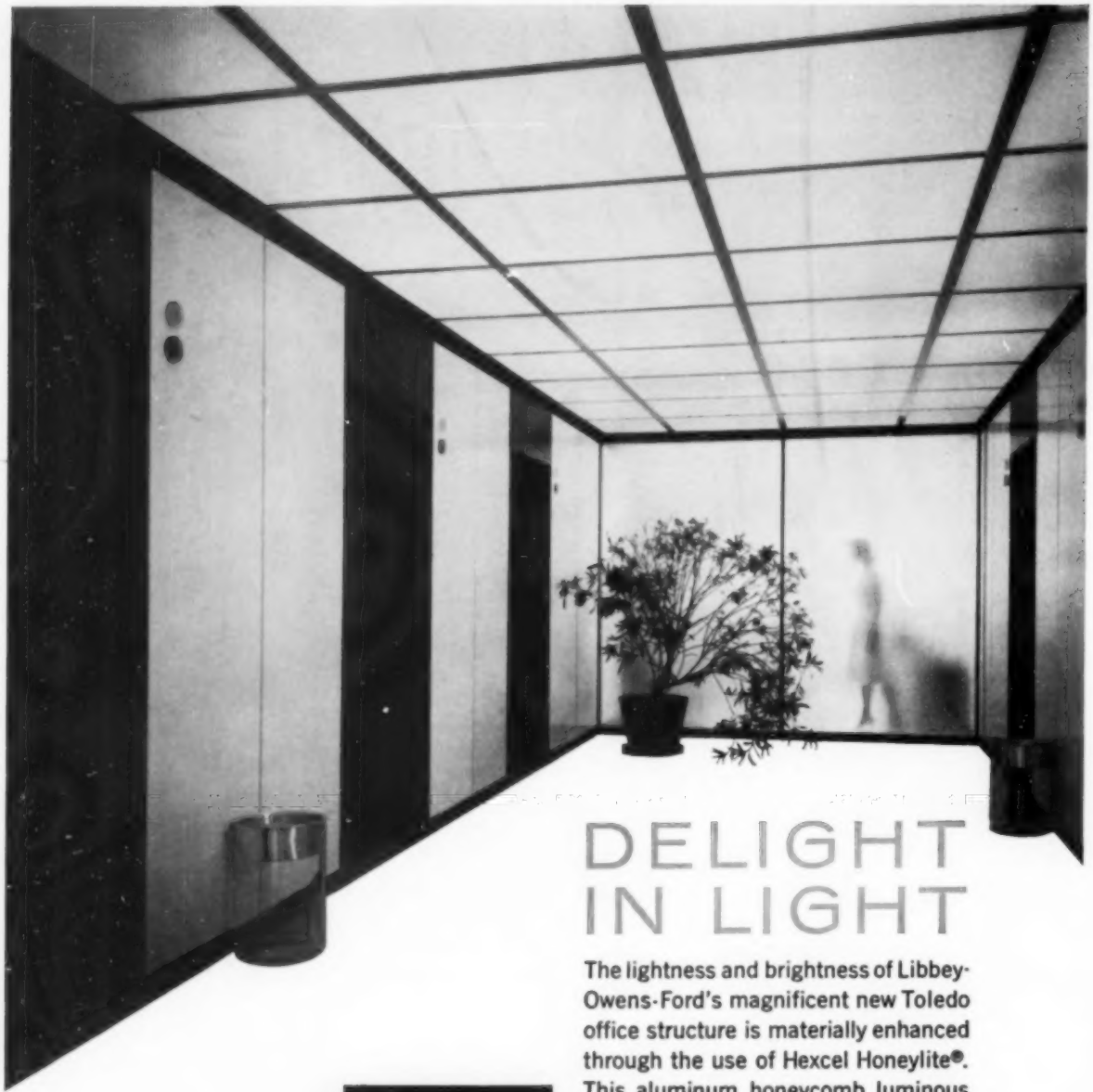
Mfg. in Canada by: Advance Transformer Co., Ltd. 5780 Pare St., Montreal, Quebec

ADVANCE®

WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF FLUORESCENT LAMP BALLASTS

TRANSFORMER CO.

2950 NO. WESTERN AVE. CHICAGO 18, ILL. U.S.A.



DELIGHT IN LIGHT

The lightness and brightness of Libbey-Owens-Ford's magnificent new Toledo office structure is materially enhanced through the use of Hexcel Honeylite®. This aluminum honeycomb luminous ceiling system achieves shadow-free, maximum utilization of fluorescent lighting, yet effectively conceals all electrical and mechanical systems. Even air conditioning is installed above the Honeylite panels. All fifteen floors of this installation feature Honeylite ceilings, representing over 120,000 sq. ft. of this totally proven light diffusing system. Owner: Libbey-Owens-Ford, Toledo. Architects: Skidmore, Owings & Merrill. General Contractor: George P. Fuller Company, Electrical Contractor: Rogers Electric, Toledo. For complete Technical Data, send to your nearest Hexcel office.

HEXCEL® PRODUCTS INC.

Stronger, lightweight materials for industry

Executive Offices: Dept. G-8, 2332 Fourth St., Berkeley 10, Calif.
Plants: Berkeley, Oakland, El Segundo, Calif.; Havre de Grace, Md.
Sales Offices: Inglewood, Calif.; Fort Worth, Texas; Chicago, Ill.; New York, N.Y.; Havre de Grace, Md.
Available in Canada through Curtis Lighting, Ltd., Toronto, Ontario

ie

ILLUMINATING ENGINEERING

THE JOURNAL OF THE ILLUMINATING ENGINEERING SOCIETY

August 1961

Vol. LVI, No. 8

1960-1961 Officers

President
Richard G. Slauer

Vice President
James R. Chambers

Vice President
G. Franklin Dean

General Secretary
J. Dixon Mitchell

Treasurer
W. P. Lowell, Jr.

•

Editor
Ruby Redford

•

Advertising Manager
Clayton E. Ellis

•

Assistants
Barbara E. Marwell, Editorial
Adelaide Philiba, Advertising

•

Publications Committee
R. W. Morris, Chairman
Charles L. Amick
B. S. Benson, Jr.
Brooks Chassaing
George W. Clark
Arthur Jaeger
Elizabeth A. Meehan

•

Managing Director
A. D. Hinckley

Technical Director
C. L. Crouch

Contents

465 One Turn of the Merry-Go-Round, An Editorial
466 Some Concepts of Electrical Space Conditioning—W. S. Fisher
473 Structural and Space Limitations—Realto E. Cherne
477 Chaos in the Ceiling—Stephen S. Squillace
481 Planning Ahead—Murray L. Quin
485 Radiant Control of Lighting Heat Loads—Gershon Meckler and John S. Hickman
494 Acoustical Considerations in Designing Integrated Ceilings—J. A. Curtis
502 Single-Case Air-Handling Troffers: Design Concepts, Installation Techniques—Dana W. Rowten and Richard E. Harz
506 IES Lighting Data Sheet—Series XXVI Lighting a Jewelry Store (12-122)
507 Coordinated Engineering Elements—John J. Andrews
511 Remodeling for High Levels, High Comfort, Heating, Air Conditioning—N. T. Kridel and L. C. Twichell
516 Lighting, Heating, Coordinated Air Conditioning for New Construction
520 Views and Opinions—The Need for Caution—Ward Harrison
521 Applications—a selection of installations featuring combined lighting and air conditioning
9A Lighting News
1961 Regional Conferences, 11A; About People, 24A; Scheduled Events, 27A; New Members, 28A
31A IES Publications
35A New Equipment Data
38A 1961 National Technical Conference Preprints
44A Index to Advertisers.

Committee Personnel—Refer to April 1961 Illuminating Engineering

Sustaining Members—Refer to Section I, March 1961 Illuminating Engineering

STATEMENTS and opinions in articles and papers in ILLUMINATING ENGINEERING are the expressions of contributors and do not necessarily represent the policies or opinions of the Society. Official Society opinions are expressed only in official committee reports specifically approved by the Council of the Illuminating Engineering Society.

ILLUMINATING ENGINEERING SOCIETY

EDITORIAL and ADVERTISING offices
1860 Broadway, New York 23, N. Y.

PUBLICATION office 32d Street & Elm Avenue, Baltimore 11, Md.

Founded 1906

ILLUMINATING ENGINEERING: The Journal of the Illuminating Engineering Society. Copyright 1961 by the Illuminating Engineering Society. Published monthly in the United States of America. Entered as second-class matter at the Post Office, Baltimore, Md. Acceptance for mailing at special postage rates provided for in Section 1103 P.L.&R., Act of October 3, 1917. Authorized July 16, 1918. ¶ Subscription $18 per year plus extra postage to all countries to which second-class postage rates do not apply; single copies $1.50. ¶ Address changes must be received at I.E.S headquarters by the first of the month to be effective with the issue of the next succeeding month.

It's Decidedly Better ROOM ILLUMINATION

It's a Decidedly Better READING LAMP

It's a Decidedly Better NIGHT LIGHT

It's a Decidedly Better ELECTRIC OUTLE

See how versatile, how considerate, how beautiful a Hospital Bed Light can be! See the

NEW DAY-BRITE TRANQUILITE

This beautiful blending of form and function is as right for replacement applications as in the newest hospitals. Wherever TRANQUILITE is used, it creates a warm, inviting atmosphere. Both upward and downward lighting is considerately soft, thanks to Cleartex® type panels, making TRANQUILITE ideal for multiple-patient rooms and wards. Fully enclosed for easy cleaning, TRANQUILITE is designed for economical maintenance. And like all Day-Brite equipment, it's easily installed, too. TRANQUILITE . . . the "Decidedly Better" Hospital Bed Light by Day-Brite! **Day-Brite Lighting, Inc., St. Louis, Mo. and Santa Clara, Calif. In Canada: Amalgamated Electric Corp., Ltd., Toronto 6, Ontario.**

Available in 2- or 4-foot length, stainless steel or baked white enamel finish

DAY-BRITE

NATION'S LARGEST MANUFACTURER OF COMMERCIAL AND INDUSTRIAL LIGHTING EQUIPMENT

For Free Booklet
on TRANQUILITE and Day-Brite's complete line of hospital lighting equipment, contact your Day-Brite representative listed in the Yellow Pages . . . or mail coupon.

Day-Brite Lighting, Inc.
6260 N. Broadway, St. Louis 15, Missouri
Please send booklet on Day-Brite hospital lighting equipment.

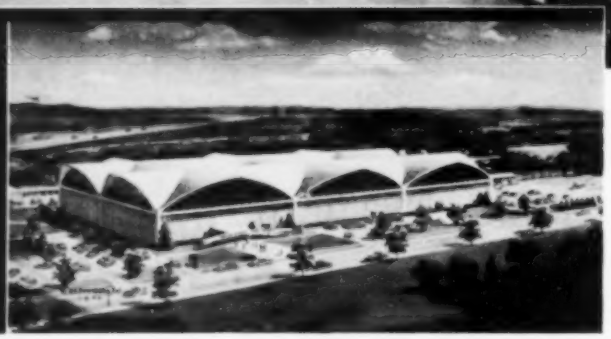
Name.....

Firm.....

Address.....

City.....State.....

Experimental Automatic Post Office Gets PROVED-IN-SERVICE Lighting with Standard Fixtures



The ceiling fixtures in the lobby of this history-making edifice came right out of our new Litecontrol catalog. The "special" character of this equipment is that it delivers high intensity illumination without glare at a *budget-controlling, in-stock cost*. Your money can't buy better. Yes, and as you can see, these fixtures are handsome too . . . they blend beautifully into this modern interior.

The post office may be experimental but this Litecontrol lighting has been *proved in service*. Fixtures are 4 foot square, have eight 40 watt lamps and use Holophane No. 6025 acrylic prismatic lenses. For commercial lighting that looks good in a ceiling and looks good in a budget — call on Litecontrol.

INSTALLATION: Experimental Mail Processing Plant and Post Office, Providence, R. I.
ARCHITECT & ENGINEER: Charles A. Maguire & Associates — Abraham I. Israel — Providence, R. I.
ELECTRICAL CONTRACTOR: Brady Electric Co., Inc., Fall River, Mass.
DISTRIBUTOR: Graybar Electric Co., Providence, R. I.
LITECONTROL DISTRICT SALES ENGINEER: Dallas G. Dearmin, 5 Hillcrest Avenue, Greenville, R. I.
AREA SHOWN: Main Lobby
CEILING HEIGHT: 10'-6"
FIXTURE SPACING: 7' x 10'
FIXTURES: Litecontrol Nos. 4384RS-6025 and 9344RS-6025 (over counters)
AVERAGE INTENSITY: Approximately 100 footcandles in service.

LITECONTROL
Fixtures
KEEP UPKEEP DOWN
LITECONTROL CORPORATION,
36 Pleasant Street, Watertown 72, Massachusetts

DESIGNERS, ENGINEERS AND MANUFACTURERS OF FLUORESCENT LIGHTING EQUIPMENT DISTRIBUTED ONLY THROUGH ACCREDITED WHOLESALERS

One Turn of the Merry-Go-Round

BACK IN THE thirties we brought to a halt an old puzzling circle. Up to then we had a heat problem in lighting. But we "solved" it. We had the fluorescent lamp and we had air conditioning. Levels as high as 50 footcandles—even 75!—were no problem at all.

THEN ALONG came another turn in lighting progress. Two years ago new lighting levels were established—in most areas "breaking 100." This was a long over-due step for improved seeing conditions. Coming round again, however, was—what to do with the heat.

THE FIRST approach was apparently way off. The heat from 200 footcandles was usually mentioned negatively, as a liability. Not so! It can be an asset. Two outstanding examples are cited in this issue (pages 511 and 516) where the heat from the lighting is a plus factor in the building design—definitely an asset. In both these buildings, and numerous other smaller installations, the lighting is the heating system, in winter.

IN SUMMER, what? The solution of this problem has been the most interesting subject in lighting for the past two years. Panels, forums, and speeches have been devoted to it at many an IES meeting. An IES Committee on Lighting and Air Conditioning has been appointed to study its every angle. The sum total of many of these panels and discussions, including the committee studies, have been brought together for this special issue on "Integration of Lighting, Heating, and Cooling."

SOLUTIONS now in practice may be only the beginning. Still in the future are such things as: Integrated air cooling and lighting with suspended luminaires; new solutions to the ceiling space problem; light source developments for more light, less heat; and many others, no doubt.

IN ANY CASE, partnership, rather than competition, has developed among the engineers concerned with environmental comforts; *viz.*, lighting, heating, and cooling.

Concepts of

FOR MANY YEARS the principal emphasis in building design has been to create better, more desirable environments for the people who live and work in them. As better environments have evolved, lighting has played an increasingly important role. For example, human visual performance has been greatly enhanced in work areas where more light is comfortably provided. As the versatility of lighting for creating pleasant, attractive and colorful environments is put to work, human satisfaction and pleasure have been increased.

Lamps as Heat Sources

As a result of the greater use of lighting, a point has been reached in present-day application where the lighting may have a considerable effect on the thermal aspect of an environment. This is because every watt of electrical energy consumed by a lamp generates 3.4 BTU's per hour. Light itself is a form of heat, raising the temperature of any object that absorbs it. In addition, a light source generates other forms of heat such as invisible radiant energy (infrared) plus conduction-convection heat. With fluorescent and mercury lamps, there is also a ballast which consumes some electric power that is dissipated in the form of heat (Fig. 1).

Limitations of Conventional Practice

Lighting is not the only source of heat in a building interior. On sunny days, the solar heat transmitted through glass windows and through walls and roofs can be considerable. In some office buildings, the expanded use of electronic business machines creates heavy concentrations of heat. In schools, stores, and auditoriums, the heat generated by people may be a principal consideration in the heating and cooling. However, the heat load in a modern building from all sources—solar, lighting, people, machines, etc.—may be of such magnitude as to tax the capabilities of conventional methods of handling it. For example, there are limits to the number of air changes and the temperature of the supply air that can be introduced into a space. If these limits are exceeded in an effort to handle greater heat loads, there may be problems of drafts and moisture condensation. However, other approaches to handling heat loads, especially those which capitalize on the possibilities for controlling and utilizing lighting heat, offer excellent opportunities for reducing the heat in the occupied part of a room and improving the thermal design.

To do this requires that a significant part of the

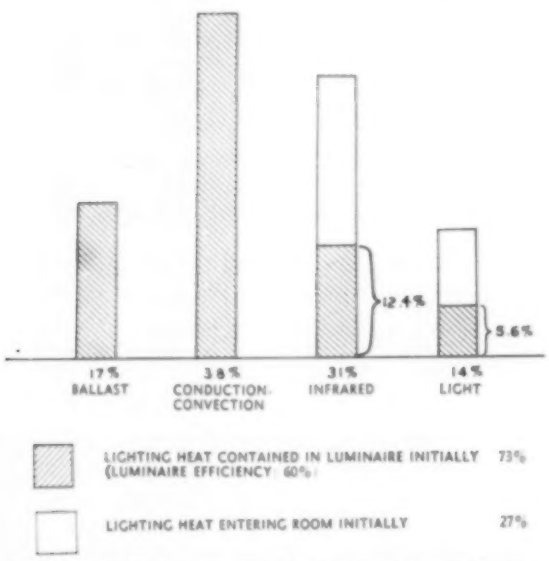


Figure 1. Initial energy distribution of a 40-watt fluorescent lamp and ballast. The distribution is modified by the installation of the lamp in a fixture having an assumed efficiency of 60 per cent.

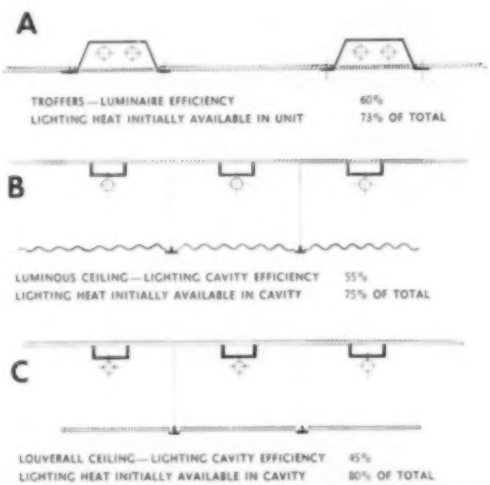


Figure 2. An analysis of the quantity of lighting heat capable of being controlled can be made for any specific lighting situation. Three are shown above. Although only a small proportion of the lighting heat enters a room initially, if some method of removing it from the fixture is not employed, the heat will build up until it enters the room at the same rate it is generated.

Electrical Space Conditioning

By W. S. FISHER

lighting heat be brought under control *before* it enters the occupied part of a room. Once this is accomplished, the captured heat can be recirculated, transferred through heat exchangers, exhausted to the outside, mixed with outside air in various proportions for recirculation, etc., depending upon the particular requirements for heating or cooling and the most desirable method of handling it.

Electrical Space Conditioning

The importance of modern lighting as related to the thermal aspect of an environment has brought about the concept of Electrical Space Conditioning (ESC). In its basic form Electrical Space Conditioning relates to the use of electrical means to coordinate lighting and the temperature of an environment. However, in broad concept ESC could include not only lighting and temperature, but also humidity, cleanliness, bacteria content, ion content, and some aspects of odor control. All these quantities can be controlled or regulated with electrical devices and all may, at one time or another, be important to the atmosphere of an environment.

AUTHOR: Chairman, IES Committee on Lighting and Air Conditioning, General Electric Co., Nela Park, Cleveland, Ohio.

Controlling Lighting Heat

The most important aspect of ESC from the standpoint of system design and economics is the lighting-temperature relationship and the necessity for controlling lighting heat. Fortunately, much of the lighting heat lends itself to control. For example, the conduction-convection heat and ballast heat can be controlled at the luminaire by a regulated air flow, by circulating water, or by thermoelectric devices. In addiion, that part of the radiant energy (infrared and light) which is absorbed by the luminaire and converted to conduction-convection energy can also be controlled. In many practical examples, from 50 per cent to 80 per cent of the lighting heat is available for control before it enters the occupied space. (Fig. 2).

The use of air circulated through lighting systems is one fundamental method of controlling lighting heat. Several suggestions for regulating the lighting heat with air flow are included in the list which follows, the techniques varying with the lighting equipment employed and some of the thermal design criteria. Some of the methods provide for control and utilization of lighting heat during the heating season, but may not significantly reduce the cooling capacity required in summer. Others may provide control that will both utilize heat in winter and reduce cooling tonnage in summer (such as the method employing ventilation waste air, Fig. 3.) All have as a common objec-

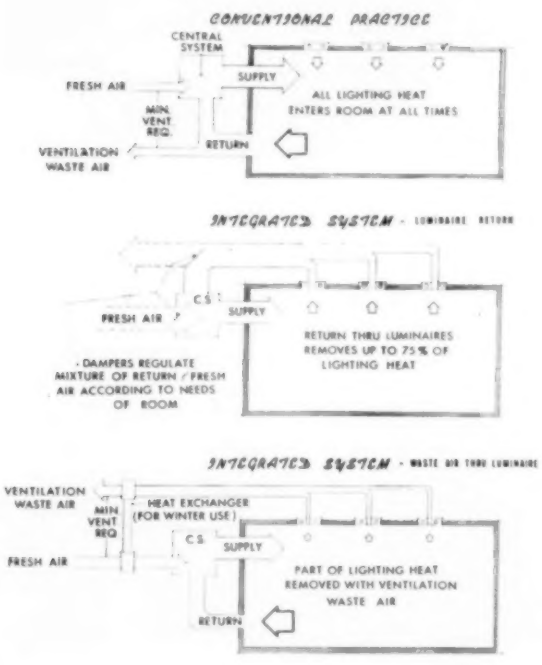


Figure 3. Conventional method of controlling lighting heat compared to two types of "integrated" systems. System B makes all or any part of the lighting heat available during the heating season, reduces lighting heat in room at all times, requires less air to be supplied to room (by carrying it through a higher temperature rise through the fixtures), but does not necessarily reduce tonnage requirements for air cooling. System C can control 40 to 50 per cent of lighting heat in most situations, reduce air cooling tonnage in proportion to heat picked up, make heat available in winter and reduce volume of air which must be supplied to the room.

Figure A. Lighting is especially important to the functioning of this convention auditorium and exhibit space. Luminaires for incandescent lamps provide about 40 fc of general lighting, 100 fc over an area the size of a basketball floor and as much as 300 fc in local areas. Luminaires are designed with apertures opening into ceiling cavity, through which ventilation waste air is exhausted into cavity and then to outside. Some lighting heat and solar heat transmitted through roof are removed, effecting a saving of 20 tons of refrigeration.

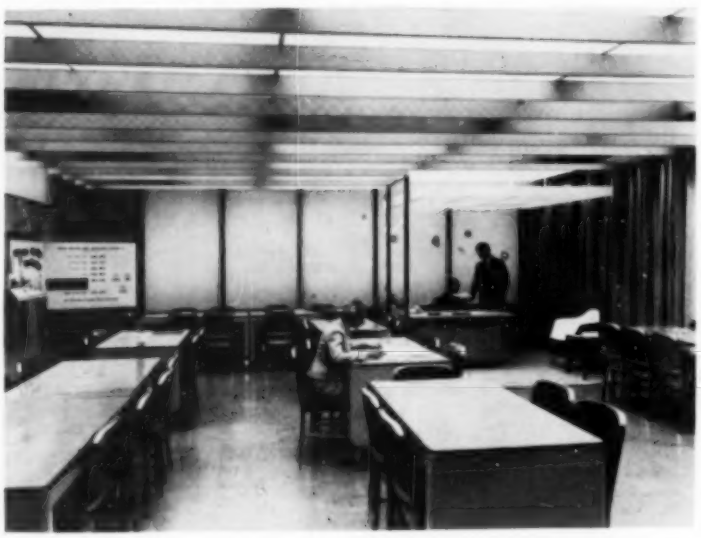


Figure B. This demonstration area was designed for visual and thermal comfort with about 400 fc provided for 50 people in an 850-square foot room. Air is supplied conventionally through air diffusers in ceiling. Return is also conventional. However, ventilation waste air is exhausted through 1500-ma luminaires which pick up 40 per cent of the lighting heat before it enters the room. Luminaire exhaust is controlled with duct system which provides for recirculation of heat to central system or exhaust to outside, as desired. Principles employed here are well-suited to many environments, such as offices lighted to levels of 100-150 fc.

tive the reduction in lighting heat that must be controlled in the occupied space. This reduces the volume of air required for heat control in the room and carries the air which is used through a higher temperature rise, thereby improving system efficiency and enhancing thermal comfort.

Techinques for Control

1. Recessed and Surface-Mounted Luminaires

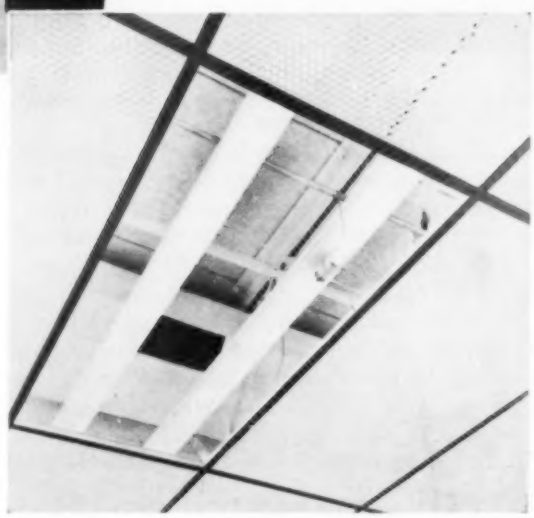
a. Circulate return air through luminaires into ceiling cavity or return duct system. Air should return through *all* luminaires and air path should be directly over lamps for maximum heat transfer in most applications.

b. Circulate ventilation waste air through luminaires (see application examples A and B). This is that part of the return air which must be exhausted to the outside to allow for fresh make-up air. In many office buildings this may amount to from 0.2 to 0.3 cfm per square foot. This technique may remove as much as 50 per cent of the heat load which can be used in winter or "dumped overboard" in summer, reducing the air cooling tonnage requirements significantly.

c. Circulate return air across ceiling cavity to transfer heat from back sides of fixtures into cavity. Units should be designed to maximize heat transfer out the back with cooling fins, black finishes, etc.

d. Circulate outside air through ceiling cavity. This will remove some heat up to the point where

Figure C. This drafting room is part of a 5000-square-foot office comfortably lighted to 200 fc. System controls much lighting heat for use during heating season. Return air travels from occupied space through openings in plastic ceiling, circulates past lamps picking up heat, and goes into one of several lines of exhaust ducts on ceiling cavity (photo below). Return air can be recirculated, exhausted to outside or mixed with various proportions of outside air. Lighting heat handles building heat losses to 5-10 degrees above zero. Below this temperature, electric heaters in supply ducts supplement lighting heat. Owner was particularly pleased with system during coldest part of last winter.



the temperature of the outside air is equal to that which the cavity would attain if not ventilated. On the top floor of a building it may also remove some of the solar heat gain through the roof.

2. Louverall and Luminous Ceilings

a. Circulate return air through the lighting cavity. (See application examples C and D.) Air circulation through all parts of the cavity and around all of the lamps is essential to achieve maximum heat pick-up.

b. Circulate ventilation waste air (discussed in 1b) through the lighting cavity in installations where there is sufficient air volume to achieve a

Figure D. This electric utility property will have about 200 fc of illumination over eight floors when remodeling and expansion are completed. Varying requirements for heating and cooling called for zoning of perimeter and interior parts of building. Air return for both perimeter and interior zones is through ceiling cavity, to pick up lighting heat before it enters occupied space. Return air enters vertical shaft at building core for handling according to building needs and as economics suggest. Installations of this type are valuable to the community as examples of integrated lighting, heating and cooling, and to the lighting profession for the performance data they provide for use in future designs.

Figure E. This demonstration office has 450 fc of comfortable illumination from a lighting system that is an important element of architectural design as well as a principal factor in thermal design. In the technique used here, thermal requirements for the room and the lighting cavity are handled separately. About two-thirds of the lighting load is removed from the ceiling cavity so that only one-third of the lighting heat imposes itself on the occupied space.

significant amount of control. Circulation to all parts of the cavity is essential.

e. If the lighting cavity is sealed off from the occupied space, employ a separately-controlled air circulation system. (See example E.) This is especially appropriate for installations such as the "white rooms" of industry or office areas where 300 to 500 footcandles, or more, are employed.

d. Where cellular-steel floor construction is employed, some of the cells may be used as ducts for return air or ventilation waste air. A pattern of openings in the ducts can be developed to achieve good circulation of air through all parts of the lighting cavity before it passes into the ducts.

3. Suspended Luminaires

a. Continuous rows of luminaires may be constructed with integral air ducts through which return air or ventilation waste air may be passed so as to pick up heat and remove it from the luminaires. New fixture designs are necessary to implement this scheme.

b. Circulation of return air or ventilation waste air from the occupied space up through and around the luminaires into a ceiling return will carry off much conduction-convection heat before it enters the occupied zone. (See application examples F and G.) Good circulation around all luminaires and through all parts of the ceiling is essential.

The foregoing list is not meant to be all-inclusive and other techniques or combinations of techniques will, no doubt, be employed as experienced designers investigate the particular requirements of specific jobs.

It is of interest to note that applications where the higher-loaded fluorescent lamps are used may offer the maximum opportunity for heat control. This results from the higher bulb wall temperature at which the lamps operate and, for a given volume of air, should give a higher temperature rise.

Other Methods of Heat Control

In addition to air as a control medium, there are also excellent opportunities for systems employing circulating water (or other suitable liquids). Such systems which are now in use employ tubing mechanically attached to luminaires to remove conduction-convection heat. Some of the possibilities for circulating water systems are covered in greater detail in another article of this issue.

The use of thermoelectric devices should not be overlooked as a possible method for controlling lighting heat. While the potential advantages of such applications must wait for product and system development, it would appear, in theory, that they have much to offer.

Advantages of Control

If advantage is taken of the opportunity for controlling the heat, it has these potential benefits:

1. Improved thermal comfort may result through reduction of radiant energy effects (lower lamp and fixture temperatures).

2. The volume of air needed to control heat in the occupied space can be reduced.

3. The tonnage of cooling equipment can be reduced where ventilation waste air is used to control the lighting heat.

4. Not as much conventional heating capacity needs to be provided where lighting heat is utilized to replace building heat losses.

5. The light output of fluorescent lamps may be

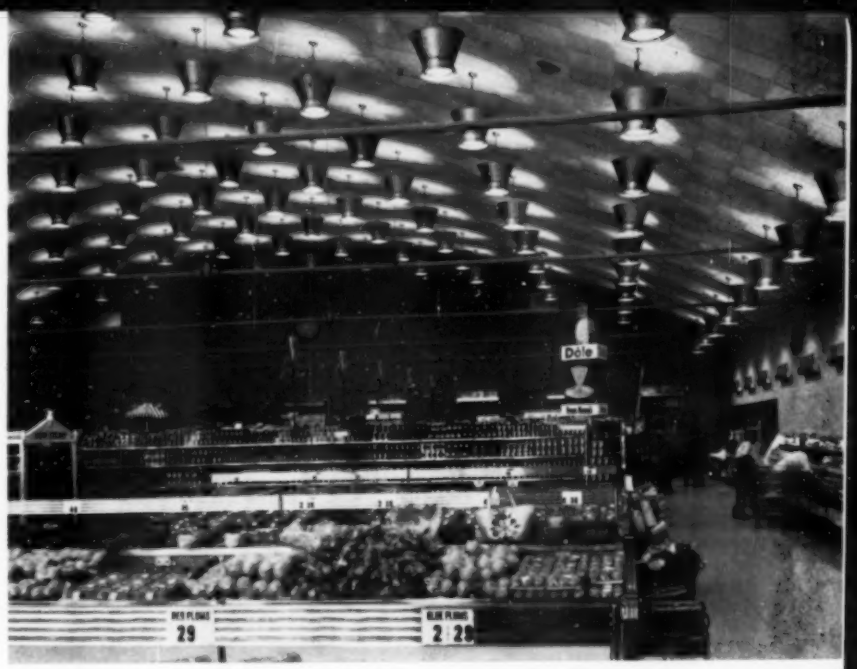


Figure F. Incandescent lighting system of this supermarket provides about 80 fc of general illumination plus 80 per cent of the building's heating requirements for a design condition of −5°F. Since this contribution to building heat losses was considered in design, there were substantial savings in investment for conventional heating equipment. In summer, ventilation waste air can be exhausted from high ceiling area, drawing warmest air out of the space and reducing load on air cooling system.

increased where removal of heat provides a more favorable ambient temperature for lamp operation.

6. The performance of fluorescent lamp ballasts may be enhanced by reduced ambient temperatures.

If lighting heat is not controlled at its source there may be radiant energy effects due to the temperatures achieved by lamps, fixtures, and ceiling parts. This may either bring discomfort to occupants of a room or require that room temperature be reduced to lower than normal values to overcome the radiant effects. A conventional approach to heating and cooling also obviates the possibility of savings in mechanical equipment, since refrigeration would be added in proportion to the increased lighting load, and the contribution of lighting to building heat losses would be ignored.

Lighting Compared with Heating Requirements

However, lighting's potential contributions to a building's heat losses are too significant to be ignored. In one analysis the heat contributed to a multi-story office building by an average lighting load of 9 watts per square foot throughout the building (about 150 footcandles) equalled the heat

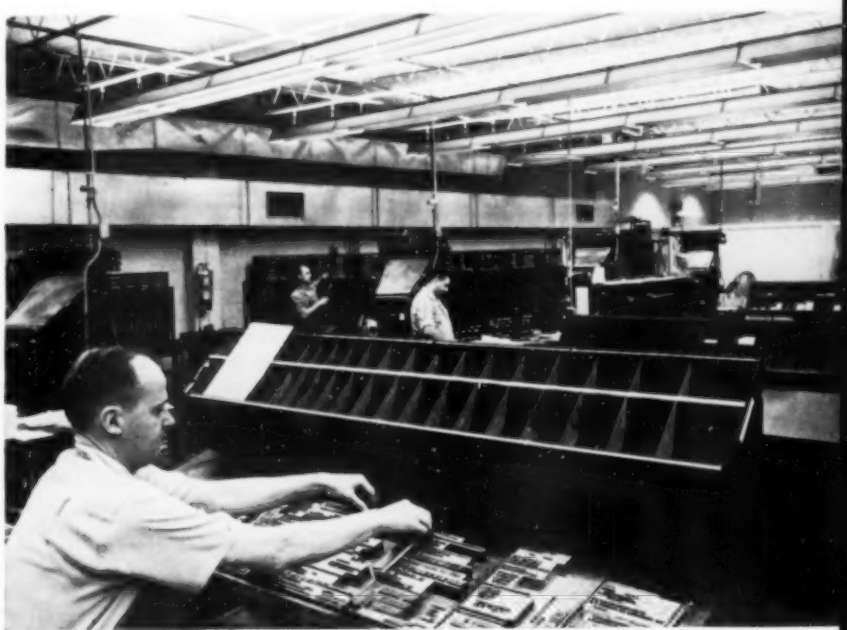


Figure G. This typography plant is located in an all-electric building where lighting teams with heat pump for economical year-round air conditioning. Aluminum luminaires equipped with 1500-ma fluorescent lamps provide about 200 fc of illumination with exceptional visual comfort. Contribution of lighting heat aids performance of heat pumps when outside temperatures are low.

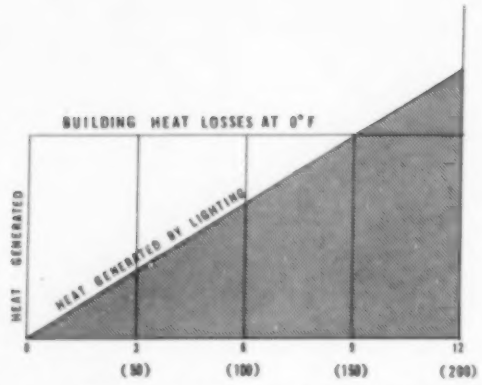


Figure 4. This graph is based on heating requirements for a multi-story office building having commonly employed design features. Lighting heat can provide a significant portion of a building's heating needs, but due to varying requirements in different parts of the building, it must be brought under control in order to be used effectively.

losses at 0°F (Fig. 4). Six watts per square foot (about 100 footcandles) could contribute two-thirds of the heat losses if it were adequately controlled and utilized. Similar analyses could be worked out for lighting as related to the heat losses of any kind of building structure.

Though a building's lighting system does not usually operate when the building is empty (except for advertising purposes), this could be done if it were desirable to do so to replace heat losses. Some stores and offices during the winter turn their lighting on one or two hours before the building is occupied to bring the temperature up to comfortable levels.

Buildings having their lighting systems operated by thermostat at night are quite conceivable for the near future. If such practice could save a substantial investment in conventional heating equipment, it might prove to be a more economical form of heating.

Economics Favor Electric Heating

If the available lighting heat furnishes only part of a building's losses, additional heat will be required. However, the economics of providing the additional heat may be somewhat different from that of conventional heating systems sized to handle all of a building's heating requirements. This means that the economics of electric heat with its relatively low initial cost may be very attractive in combination with modern lighting.

It is also likely that the economics of heat pump application may be less dependent on the geographical location of the installation and the outside design temperature when teamed with modern lighting in an ESC environment. For example, the heating and cooling demands on capacity may be more nearly balanced where lighting makes a significant contribution to the heating, as compared with the usual situation where heating may require two or three times the BTU capacity of the cooling cycle. Therefore, the lighting-heat pump combination may be able to handle all the heating needs without calling for supplementary heat. In addition when a building must be "zoned" because of varying heating and cooling needs in different parts of the building, the heat pump can operate effectively as a heat exchanger transferring lighting heat from one zone which has an excess to another which requires heat.

It becomes obvious from the preceding discussion that the contribution of lighting to heating should not be overlooked where illumination levels are employed which meet or exceed current recommendations. While conventional approaches to handling the lighting heat have been used in many such installations to date, these ignore the opportunities for improved thermal comfort and lower costs of cooling and heating.

Coordinated Efforts Required

The significance of Electrical Space Conditioning to the electrical and mechanical engineer is that their work will require coordination to a greater degree than ever before. It will not be practical to design the lighting as something separate and apart from everything else in a building. Nor will it be satisfactory to size the cooling equipment to handle "x" watts per square foot of lighting load and neglect the BTU/hr contributed by lighting when planning the heating system.

New Approaches and Equipments Needed

The effective control and utilization of lighting heat requires some fresh approaches and the exercise of ingenuity on the part of electrical and mechanical engineers in their design of integrated systems. Also, new equipments are needed from manufacturers together with performance data to make it easier for users to take advantage of the potential benefits of ESC.

However, there are already a number of examples where resourceful architects, engineers, and users have worked out successful solutions that capitalize, at least in part, on the thermal properties of lighting systems. Some of these installations are shown and described in this article. These and others like them are the forerunners of many more to come where lighting makes an increasingly important contribution to the environments in which we live and work.

STRUCTURAL AND SPACE LIMITATIONS

By REALTO E. CHERNE

THERE have always been problems in allocation of ceiling areas to lighting, heating mains, air conditioning supply outlets and return air grilles, and sprinklers. Concealment of duct work and piping becomes more difficult as higher levels of illumination are considered because of the required larger areas of luminaires as well as increased air quantities. Somewhere in the horizontal distribution systems, the branch ducts are served by headers or main ducts, and sprinkler run-outs are served from mains. With the tendency toward lower floor-to-floor heights and occupying of all basement areas, the availability of space for horizontal distribution of utilities has become an important issue. Engineers and architects are compelled to explore new concepts of design for the mechanical services. As the requirements increase, and the users become more demanding, costs increase and space for services becomes more valuable. This is truly a dilemma.

Vital to the successful design of a building is early as well as continuous collaboration between the architect, the structural engineers, and the mechanical-electrical engineers. If building costs for alternate structural systems are evaluated with the resultant limitations imposed on the lighting, air conditioning, heating, and sprinkler systems, a better considered over-all design will result. This will mean lower operating and maintenance costs, better user satisfacton, and generally lower investment costs.

Large multi-story buildings have central core areas for facilities and mechanical services. This permits location of air handling equipment, for example, on each floor, or alternate floors, if low pressure distribution is to be used, or centrally if high pressure distribution is to be used. Regardless of the types of mechanical systems selected, there is need for some horizontal distribution through ceiling space. Also, there will always be need for shaft space for vertical distribution. Not only is it necessary to have ceiling and shaft space, but such

AUTHOR: Consulting Engineer, Rochester, N. Y.

space must be accessible. Proper structural framing will satisfy these requirements.

Space and structural problems are more complex on large scale remodeling and renovation projects. In addition to fixed floor to floor heights and equipment weight problems, the designer must consider what, if any, of the existing equipment (or systems) can be continued in use, or modified for use in the finally selected layout. Examples:

- Are the electrical service and distribution system adequate?
- Should the heating system be removed and all heating be handled by the air conditioning system?
- Could existing ventilating equipment and duct work become part of the air conditioning design?
- Is it possible to design systems for the other mechanical services to avoid sprinkler changes?

The design of any comfort air conditioning system is based on the summation of all heat gains to the conditioned space: solar radiation; scattered sky radiation; conduction through walls and roof; lights; occupants; machinery; and outside air introduced for ventilation. The sensible (or dry) heat is separated from the latent (or moist) heat since each affects system and equipment selection in a different way. For a given room condition of temperature and humidity, the sensible heat gain largely determines the air quantity required while the latent heat determines the air dew point temperature required at the air handling apparatus. Since the quantities as well as the ratio of the two types of heat gain will vary, need for capacity control becomes obvious. Selection of the method of partial load control may influence system fundamentals and consequently space requirements.

During recent years, due to increased lighting levels larger percentages of the heat gains have been from lights.

Checking back about ten to fifteen years on air conditioning design work covering hundreds of installations, and limiting the discussion to office buildings, it was found that the watts per square foot of area varied as follows: low, .83, average, 1.66; high, 2.6. It is significant to note that the transition from incandescent to fluorescent lighting

Figure 1. The confusion of temporary and permanent lines and structural elements becomes evident on a remodeling project. (All photos courtesy of Rochester Gas and Electric Co.)

Figure 2. Ductwork for multiple-zoned dual duct high pressure system must be located with consideration for the lighting and sprinkler pattern.

did not materially affect these unit figures. This is another way of saying that lighting levels have increased from 200 to 300 per cent during the transition. A contributing reason for the apparent low watts per square foot was the arbitrary but economically justifed reduction in artificial lighting during sunlight hours. In other words, if the occupant wanted to be comfortable while sun was shining on his office windows, it would be necessary to turn off some of the lights.

Experience in recent years indicates that lights are seldom turned off during occupied hours regardless of outdoor conditions, even though the glass areas have increased from 35 per cent to 80 per cent of the exposed wall areas and natural light may be measured in hundreds of footeandles. One problem, of course, is unequal distribution of the varying intensity of natural light, aggravated somewhat by devices used to shield against solar and scattered sky radiation.

Current recommended levels of illumination for offices, varying from 70 to 100 footeandles and upward involve 3 to 5 watts per square foot (and upward). It is obvious that this increased heat gain must be removed by the air conditioning system. As the light intensities increase, the radiant effect of the larger areas of luminaires requires maintenance of lower room temperatures for comfort. If the same relative humidity is maintained, this decrease in room temperature does not materially increase the air quantity but it does add to the refrigeration load and require lower refrigerant or chilled water temperatures. This could have a serious effect on the performance of certain types of refrigeration equipment.

There is under construction in Rochester an office building modernization and alteration project involving about 100,000 net square feet of floor area.* Preliminary calculations to determine size and type of equipment and budget costs were based on 3 watts per square foot. As the design developed, however, some studies were made on the basis of maintaining 200 footeandles. This increased the lighting load to about 10 watts per square foot, a matter of 500 kw, and an increase of about 163 tons of refrigeration. If all of the heat from the lights could be made available where needed, no addi-

*For details see pp. 511-515.

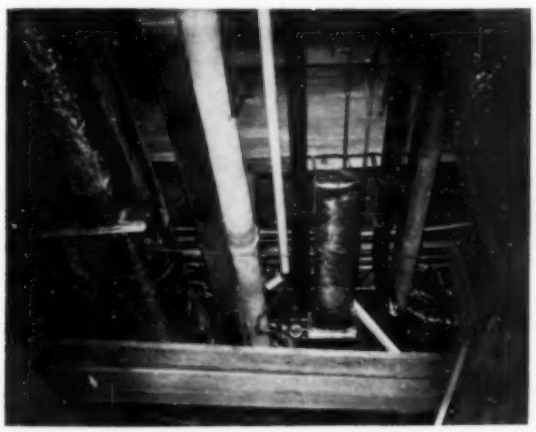


Figure 3. Electric feeders, branch circuits, heating piping, sprinklers, pneumatic control lines, supply and return air duct work require coordination of design and cooperation among trades during construction.

Figure 4. Section of finished ceiling with panel of louvers removed to show ductwork, lamps, ceiling outlets.

tional heat would be required with outside temperatures as low as zero. Consideration was given concurrently to numerous types of lighting and air conditioning systems. It became evident that the available furred space would not permit use of conventional low pressure air distribution which otherwise had some desirable features with respect to this particular situation.

It should be expected that everyone will realize that increased lighting levels must pay their own way. If the benefits do not outbalance the increased owning and operating costs, there would be little need for changing to the latest IES standards. In an effort to get a better focus on the economics of the increased cost of air conditioning required by increased lighting, some rough calculations were made. Assuming one $4,000 per year office worker for each 100 square feet of conditioned floor area and an increase of lighting load from 3 to 10 watts per square foot, it would take an improvement of worker efficiency of less than one per cent to offset the increased owning and operating costs of the air conditioning.

After analysis of the construction problems, interference with normal building usage, and costs, the management decided to proceed with the 200 footcandle installation.

Having merely outlined the nature of the space problems, it finally becomes necessary to reach design conclusions. An obvious way to reduce the amount and size of ductwork is to use a peripheral system for the outside bay on all sides of the building, with induction units which use chilled water to take care of a large portion of the sensible heat. For this particular project, this system also replaces the old cast iron radiation and low pressure steam distribution system which was starting to have high maintenance costs. Because of the magnitude of the heat gain from lights, and the influence of this heat on the controls, it was decided to use a three-pipe water distribution system to the induction units. This simplifies the air and water zoning problems and yet provides for heating of some areas while others are being cooled, without excessive operating cost penalty. Air conditioning of the periphery thus does not conflict with lighting or sprinkler layouts.

The interior areas are air conditioned by use of a double duct high velocity system. This system will provide the necessary individual room control and the minimum space requirements for ducts. Consideration was given to the use of fan rooms on each floor, but space limitations indicated the necessity of centralizing all equipment in two penthouses, one on the eighth floor and the other on the eleventh floor.

Although extensive use will be made of louvered ceilings and fixtures, the air distribution outlets are located flush with the bottom of the louvers rather than in the furred space above. Provisions are made in the design of the air and water circulating systems to make use of the heat in the return air when needed by: recirculation of any desired proportion, exhaust of moderate quantities of return air, and circulation of water which has been cooled by outdoor air rather than by refrigeration.

Design of the lighting systems gave consideration to optimum air outlet locations and there were no serious conflicts. The sprinkler heads, however, were located where lighting fixtures and air outlets permitted. Although some additional heads were required, the cost of the sprinkler system was not greatly increased.

One means of reducing duct sizes is to remove part of the sensible heat load by use of induction units, as previously described, or by ceiling panel cooling. Air is still required for ventilation as well as removing the latent heat load. Since there is no standardization of building types, sizes and uses, each project requires individual analysis. Panel cooling systems and induction unit systems, by permitting use of smaller air handling equipment, ductwork and outlets, result in considerable space saving. On the other hand, such systems require additional hours of refrigeration machine operation each year because the "free cooling" available from outside air during intermediate seasons is limited. Thus, operating costs may be sacrificed to satisfy space and structural limitations.

A number of the lighting fixture manufacturers have recently combined their research efforts with air outlet manufacturers to develop combination air diffusion and lighting units. With larger percentages of the ceiling areas occupied by fixtures, it has become difficult to find proper locations for air supply and exhaust outlets. When the costs of systems employing combination units approaches the costs of conventional systems, and when additional application engineering problems have been solved, it is expected that wider use will be made of integrated equipment.

In summary, increased heat gain from higher levels of lighting requires maintenance of lower temperature for comfort, increased air quantities, increased space, and higher installation and operating costs for air conditioning. At the same time, the need for full capacity, properly controlled, air conditioning becomes more evident. Justification must be demonstrated by true economics as this is the relentless and final test. As engineers, we are interested and concerned with the economics and total environment of the projects we help design.

CHAOS IN THE CEILING

By STEPHEN S. SQUILLACE

To look at a reflected ceiling plan, as developed on an architectural drawing, is to catch a glimpse of the true meaning of the word "chaos!" In Fig. 1, a more or less typical situation, we find the following items occupying the ceiling space.

- Lights, exit signs, visible and audible paging and warning signals, electric signs and emergency lights.
- Loud speaker equipment.
- Diffusers, return air units, sprinkler heads.
- Access panels, smoke detectors and general fire detection units.

An analysis of the plan shows that the problem is two-fold. First, all items in the ceiling contain diffusing and distribution properties. For example, sprinklers must distribute water evenly, lights must distribute light energy uniformly, sound and air have distribution characteristics which must be adhered to. Warnings, exits and emergency units must be located with a view towards visibility and distribution. Smoke detectors and fire detection units again present location problems.

Every one of these units, it seems, does its best job of distribution at about the quarter points of the structural bay. Since all units cannot occupy the same place at the same time, then all units must compromise their best efforts and be architecturally integrated into a ceiling pattern.

Second, such an abundance of units in, on, and hanging from the ceiling, serves to create a vast sea of ducts, pipes, conduits and myriads of cables above the ceiling which frustrate the engineer, architect, owner and contractor to no small degree.

Author: Consulting Engineer, Hyde & Bobbio Inc., Detroit, Mich.

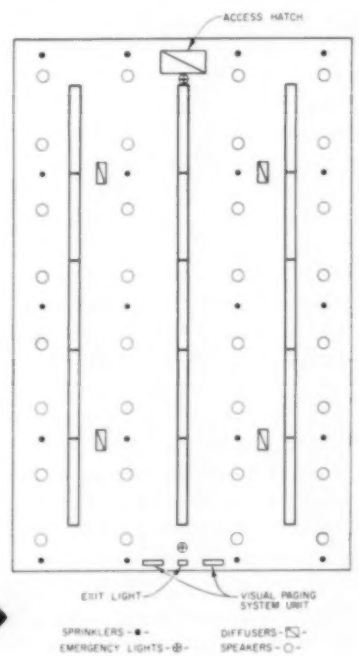


Figure 1. Lights, sprinklers, emergency lights, speakers, diffusers and access hatches all tend to clutter ceiling.

Several conventional solutions to such chaotic conditions have been suggested. None of these, in my opinion, gives the final answer as yet. Solutions offered to date are:

- Combined light and air troffers.
- Argument for reduced lighting.
- Luminous ceilings.

Considering the above solutions one at a time, our experience can be summarized as follows.

Combined Light-Air Troffers

Combined light and air troffers offer the advantage of eliminating two items from the chaotic pattern—the supply diffuser and the return air grille. However, these combined troffers bring and create their own problems. First, they do not entirely eliminate all supply diffusers and return air registers because distribution of air is often needed at points where lights should not or cannot be used. When walls of glass must be blanketed by air, diffusers must be placed here. Since lights may not be desirable at these points, the combined light and air troffer fails in this situation. The question arises: Should ordinary diffusers be used here or should the light troffer be used without lights? The cost factor will probably decide this.

Secondly, while the unions seem to have established a means for amicable installation between the two trades, the problem of responsibility still remains unanswered. Damage to fixtures, lamps, ducts, etc., usually leads to a harangue and no real acceptance of responsibility. It is an impractical stumbling block to construction, since the trades do not exhibit 100 per cent cooperation.

Third, the fixture will have, depending upon the season, a mixture of air at anywhere from 55°F to 65°F or 70°F and the lamps, therefore, may not be operating at proper efficiency. Some care has to be given, both at the supply and return units, to temperature and velocity of the air to insure optimum lumen per watt output of the lamp.

More work is needed, I think, to assure good operation of the fixture as a whole. This is especially true of the higher output lamps which have a less favorable inherent initial lumen maintenance quality than the standard 430-ma lamps.

Fourth, there is some concern among mechanical engineers about the actual distribution of the air from the troffer. Drafts upon the body are particularly bothersome and the velocities inherent in the first units of this type have been too high.

Fifth, this partial solution of using combined light and air troffers does not eliminate any costly and space-consuming duct work in the ceiling above.

However, the combined light and air troffer is definitely a step in the right direction and may well be considered as one solution, the above mentioned problems notwithstanding.

Reduced Lighting

The proponents of reduced lighting, striving to reduce the total quantity of fixtures and thereby minimize the chaotic condition, often lose sight of the fact that the lighting unit itself is only one item of many which serve to adulterate the ceiling.

The benefits of good, comfortable, high-level lighting are not a part of this discussion; suffice it to say here that reduced lighting is certainly the coward's way out of the problem and, as a matter of fact, is a weak, partial compromise which often results in an ineffective use of the space.

Luminous Ceilings

Luminous ceilings have been used quite successfully as a method of hiding the above mentioned hodge-podge of equipment. One major problem, however, is cost. If budget is at all a consideration (and where is it not?) initial cost almost eliminates it from all but the special type of building. In addition to initial cost, this system requires a time-consuming, expensive maintenance program.

The system as a whole presents an architecturally stereotyped, homogeneous, lighting solution to each and every corner of the building. Architecturally, this presents a problem of monotony which, in effect, cannot be solved. Finally, most over-all lighting systems have no real flexibility in varying quantities of light from area to area.

New Solutions

What to do? I would like to present some thoughts as to possible new solutions to this age-old problem with the hope that they may stir some imaginations.

In general, it can be said that the structural elements of the building proper, as well as its interior walls and partitions, can be used to integrate and build-in most of the lighting for the space.

As indicated in Figs. 2 through 5, the general solution discussed in this article concerns mainly an indirect type lighting distribution, with just enough ceiling lighting to raise the level of lighting and lend sparkle to the otherwise bland indirect system. In some applications, the indirect lighting may be sufficient.

It cannot be emphasized too strongly that with

such a philosophy the architect and engineer must fit things together like hand-in-glove. In general, my own attempt at doing away with most of the elements which tend to make the ceiling appear "busy" or too "cluttered" has involved all trades and has required a great amount of cooperation. The approach has been to divide the problem into two major categories—the problem *above* the ceiling and the problem *on* the ceiling.

The problem above the ceiling resolves itself into eliminating as many ducts for air heating and conditioning and as many conduits for branch circuits as possible. The use of perforated ceiling tiles, where acoustical tile is employed as the main ceiling item, is one suggestion. Such a ceiling makes use of the space as a plenum chamber for supply air and then employs slots in the tile by means of which the air is introduced into the room. Return air grilles are placed in walls. A combination of perforated ceiling tiles and luminous ceiling islands may also be used to great advantage in minimizing the duct problem above the ceiling.

The portion of the problem dealing with ceiling surface involves all items previously mentioned. Lighting fixtures are limited to a few downlights and perhaps a very few fluorescent troffers. Most of the lighting is done from the tops of low partitions, wall urns, wall floodlighting, special islands of light which flood the ceiling and special group lights integrally built with structural elements.

Sound speakers are placed above the perforated tile ceiling so that sound comes through slots from a concealed speaker. Visible and audible signals, paging, warning and emergency lights can be limited to walls and low partitions, thus eliminating them from the ceiling.

In summary, this solution minimizes the problem above the ceiling by limiting duct work and conduit work. The only items which remain visible in the ceiling itself are smoke and fire detection units, sprinklers, and access panels. The last item, of course, can be made almost invisible with proper treatment. With this treatment, the cluttered look reverts to a more reasonable pattern, such as shown in Fig. 2.

Note from Fig. 4 that much can be done with luminous walls to hide elements that are ordinarily in the ceiling. Such luminous walls (approximately four to five feet deep) can hide ducts, speakers, emergency lighting, warning signals and signs, etc., and still provide as much as one-half the total lighting in the room.

In dealing with a lighting system which is primarily indirect, one wonders about the wattage to

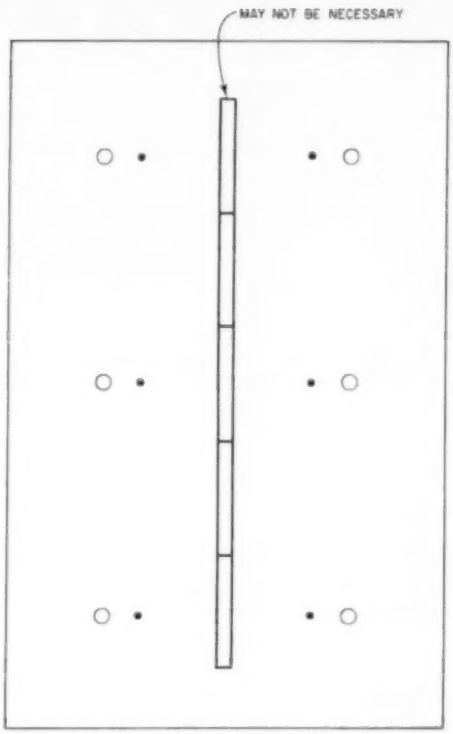


Figure 2. Ceiling plan indicating only minimum lighting in ceiling. All other elements are omitted and located elsewhere so that they are inconspicuous.

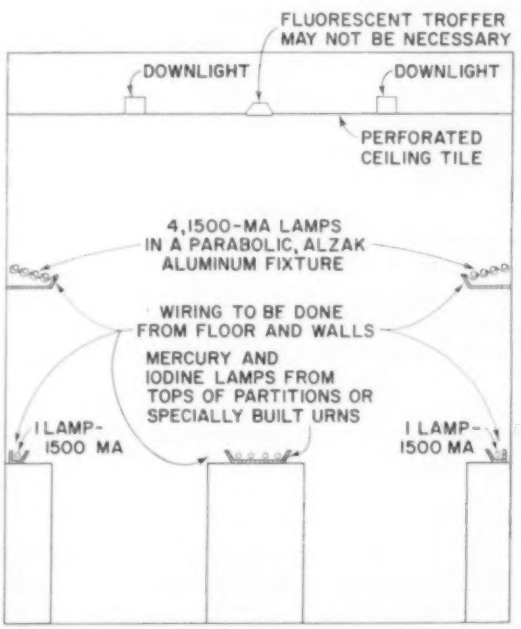


Figure 3. One possibility for design with primarily indirect lighting in high ceilings.

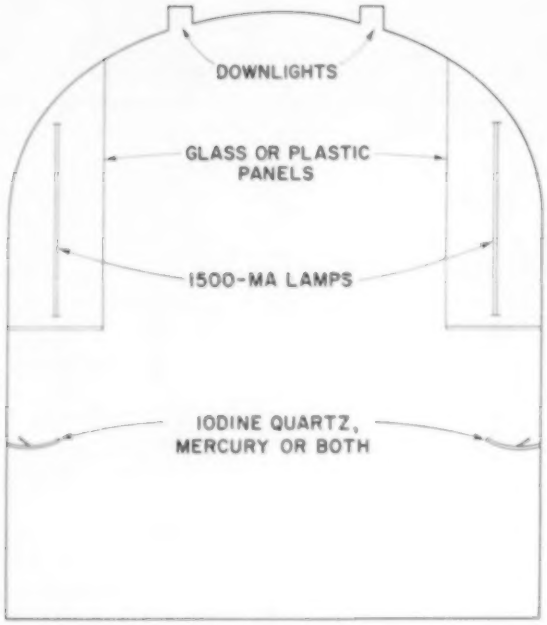


Figure 4. Other possible lighting solutions for use in high-ceilinged areas.

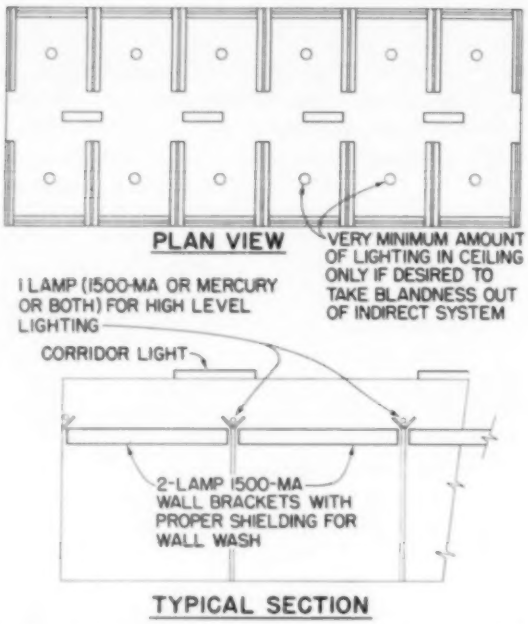

PLAN VIEW
VERY MINIMUM AMOUNT OF LIGHTING IN CEILING ONLY IF DESIRED TO TAKE BLANDNESS OUT OF INDIRECT SYSTEM
1 LAMP (1500-MA OR MERCURY OR BOTH) FOR HIGH LEVEL LIGHTING
CORRIDOR LIGHT
2-LAMP 1500-MA WALL BRACKETS WITH PROPER SHIELDING FOR WALL WASH
TYPICAL SECTION

Figure 5. Possible indirect system for low-ceilinged (eight-, nine- or ten-foot) areas.

be used in the building in order to produce the levels of illumination prescribed today. To be sure, the wattage must increase. However, in my opinion, it need not be very much greater than ordinary direct systems. With some imagination the better light sources now available may be integrated into the structure to produce higher levels.

Such sources as improved-color mercury, the newest iodine quartz lamp, and the 1500-ma fluorescent units are powerful, long-life sources with a great voltage flexibility that are crying to be used. For example, a 1000-watt mercury lamp, combined with a 1500-watt iodine lamp and a 1500-ma lamp can produce approximately 108,000 bare lamp lumens of light for 2715 watts input. It would take approximately forty 40-watt rapid-start lamps at a total of 2000 watts to produce the same bare lamp lumen output. Properly used, just three sources of light can produce very high levels of illumination within a small space. Such sources of light in a properly designed floor urn, wall screen or ceiling cove, for instance, could light an entire church nave or small auditorium.

As to the dissipation of heat for the higher output sources, we find no problem in attempting to reuse such heat for building comfort in the wintertime and to dump it in the summer. It behooves us, the engineers, to continue improving the sources of light as to heat, sound and efficiency.

In summary, this article propounds the theory that, in general, all lighting should be 75 per cent indirect and 25 per cent direct with the more efficient, more flexible sources of light used to produce the indirect component. The ordinary direct component can be produced by the standard incandescent lamps in just the right quantities to counteract the blandness of the indirect component and lend sparkle to the entire atmosphere.

September IE—Annual Abstract Issue

IE's annual presentation of the abstracts of National Technical Conference papers is scheduled for the September issue. Watch for this valuable issue containing the abstracts of 34 papers on the program of the 1961 St. Louis Conference.

PLANNING AHEAD

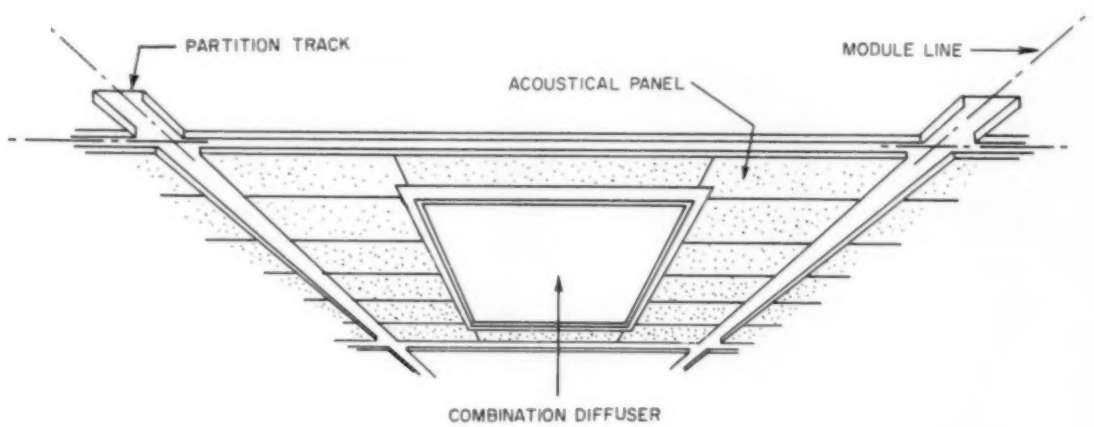
By MURRAY L. QUIN

CHANGING needs of building occupants is perhaps only surpassed in frequency today by the changing styles of feminine fashions. While each is fostered by the need or desire to rearrange, the off-again on-again ease by which the latter is accomplished has little in comparison with the former, beyond a noticeable pinch in the pocketbook. Yet, few businesses can afford the inefficiencies of operating with inadequate facilities. Unfortunately, it is also true that few buildings can cope with the rapidly changing space needs of modern-day enterprise.

In the past ten years almost every company, large or small, has felt the impact of constantly changing business methods—the necessary streamlining of systems, introduction of electronic aids, new departments and shifts in personnel. It is this complete upheaval that has forced many corporations to completely abandon their outdated facilities and to approach new construction with an understandable desire to forestall its recurrence as long as possible.

The technical problems placed before building planners and architects by the need to plan ahead for inevitable change are varied and complex. In essence, the two horizontal planes of the building shell must be adaptable to unrestricted vertical

AUTHOR: Manager of Product Research, Day-Brite Lighting Inc., St. Louis, Mo.



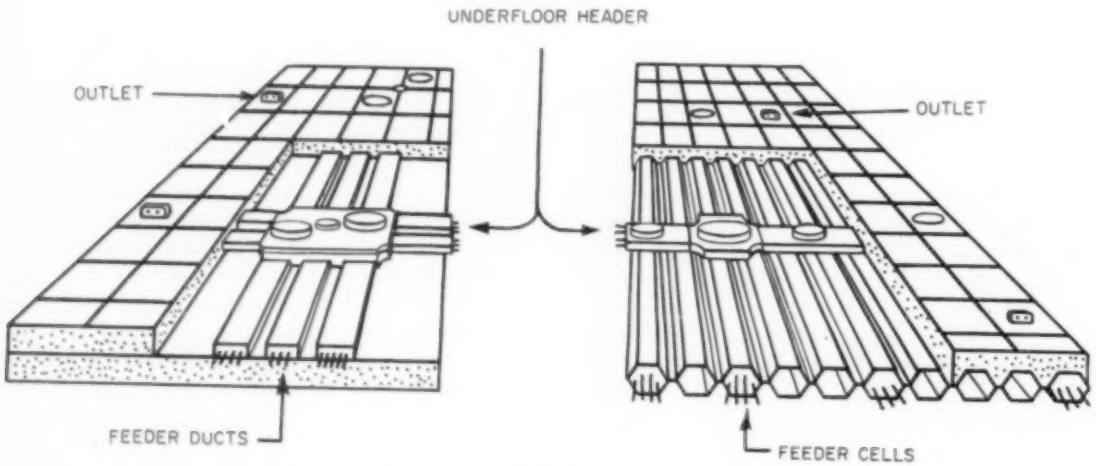
Integrated ceiling module combining acoustical, illuminating and air conditioning elements. For service flexibility, combination diffuser in center of module handles lighting and air distribution services.

plane flexibility. The degree of success in achieving this goal is dependent upon the development of paralleling flexibilities in service systems occupying horizontal floor and ceiling planes. Underdevelopment or technical limitations in any one system materially reduces the over-all effectiveness of any layout.

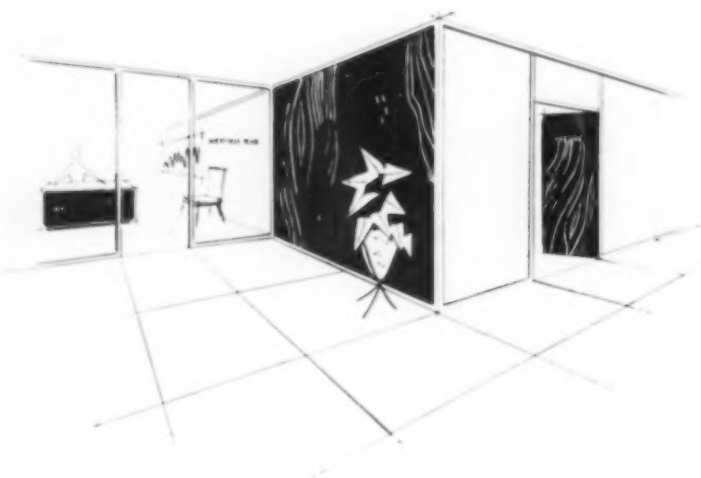
Immovable walls, the most obvious barrier to layout flexibility, gave way to prefabricated movable and expandable partition systems. Coincidentally, layout planners turned their thinking to floor plan modules. By coordinating these grids with partition panel sizes, full utilization of basic sections could be realized.

With vertical plane flexibility established, designers turned to the more difficult horizontal planes. Within these lie the preponderance of all mechanical and electrical services to the building interior. In the floor plane, ready access to power and communication services is mandatory. To achieve flexibility, underfloor duct systems and cellular steel floors were developed for use with concrete or structural steel building types. By coordinating these distribution systems with a basic planning module, telephone and electric outlet connections could be assured at any possible desk location without requiring the installation of additional raceways or conduit.

The ceiling plane has presented the most difficult of interior surfaces to engineer for flexibility. Within this plane are to be found the environmental stabilizing acoustical, lighting and air condi-



Underfloor duct and cellular steel floor systems assure floor plane service flexibility. Telephone and electric outlets may be located within each module.

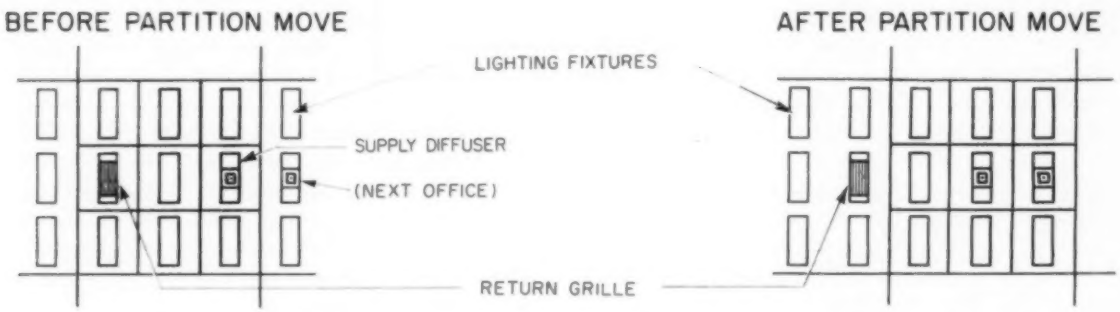


Movable partition panels may be coordinated with floor and ceiling modules to achieve flexibility in space planning.

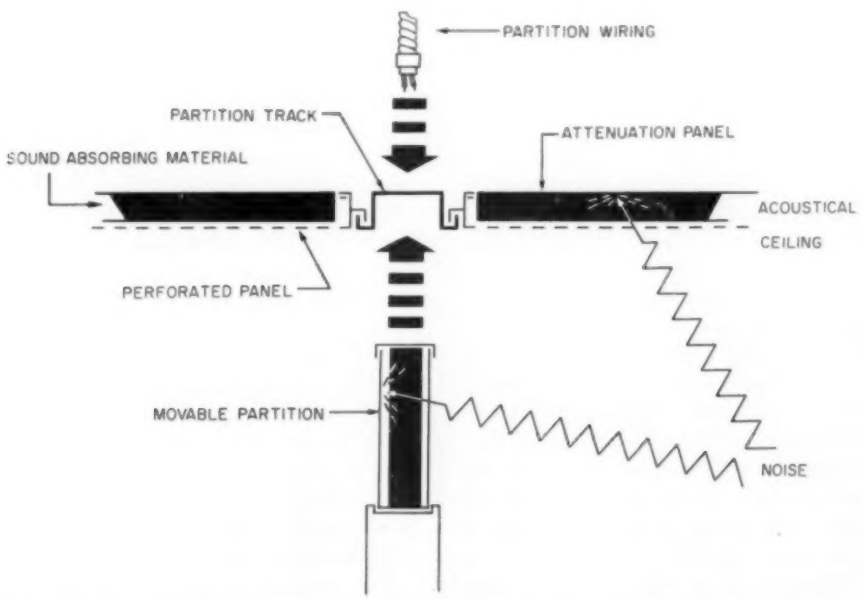
tioning elements. To achieve flexibility in the placement of elements of these three systems, early approaches concentrated on mobility through interchangeable modules. Suspended frameworks of various types were designed to extend throughout entire ceiling areas. The planning module of this suspension system matched that of the basic floor plan and movable partition sections. Acoustical panels, lighting fixtures, and air supply diffusers and return grilles were then designed to drop into place as needed in the master plan.

In theory, the initial concept was workable. However, sacrifices were readily apparent when put into practice. Layout became a game of Chinese checkers with marbles of four colors. Each color represented a component or function which contributed to the total environment of the enclosed space. Having each unit occupy a separate ceiling module became too cumbersome for complete freedom in space-use planning. First, the marbles were compromised to achieve the common size necessary for interchangeable placement. This was followed by further compromise in strategic placement. Usually, air handling units occurred where lighting fixtures should be located and vice versa. This was nothing in comparison with later developments when partition changes began. The chaos which resulted may be visualized by having the board suddenly drop and shift beneath a game of Chinese checkers.

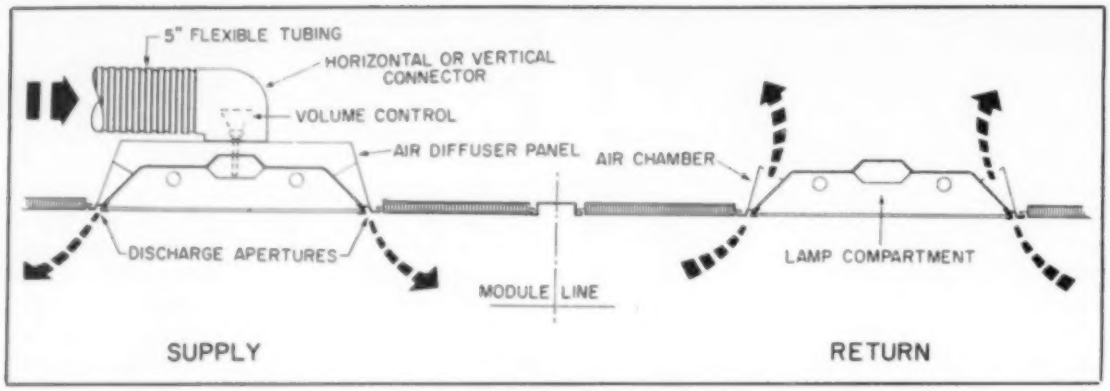
Obviously, planners were having to play with too many different marbles, or modules. In the



Prior to the integration of these components, light and air diffusers were arranged in separate ceiling modules. Flexibility depended upon mobility since partition changes necessitated ceiling rearrangements.



Grid module in ceiling plane locates movable partition and supports acoustical ceiling panels. Partition track and sandwich panel construction attenuates inter-office sound transmission.



Multi-purpose diffuser combining lighting and air distribution services.

floor plane, flexibility was achieved by having all services available to each planning grid. On the floor surface, outlets may be introduced only at time of need. In the ceiling, however, it was conceivable that all outlets could be readily available for connection in each module. Essentially each module would be a self-sufficient imaginary cubicle. This concept posed directly related problems of both appearance and cost. A practical method was needed to integrate (1) acoustical control and privacy, (2) quality and quantity of illumination, (3) air conditioning and ventilation comfort, and . . . at the same time, avoid ceiling clutter.

The technical fields represented by these three parts of the total environment have, in the past, been only remotely associated. Unity within the integrated module, however, has changed this relationship and has made the acceptance of individual product developments interdependent. Unity has been achieved through a combination of industry sponsored researches, individual company research programs, and finally, the joint research and development projects entered into by separate companies.

Architectural studies have shown that building modules based upon planning grids four to six feet square have provided a needed range of flexibility. Research into vision has provided much needed knowledge concerning minimum levels of illumination required by various tasks. Application of this research has shown that each office building module should contain a basic lighting element in order that recommended area intensities may be comfortably achieved. Acoustical research has added new knowledge on desirable background noise levels and sound transmission between offices. These advances have improved the designers' ability to apply principles of noise control and assure acoustical privacy within each building module.

Designers have long puzzled over the manner by which air conditioning and ventilation could be added to the module. Separate air supply diffusers and return grilles at each end or alongside the lighting fixture left much to be desired both esthetically and economically. Balanced design could be satisfied within the individual module; however, ceiling clutter compounded with repetitive expansion. It was apparent that a single, flush-mounted element capable of handling all lighting and air distribution functions had some merit. Since its introduction some four years ago, the "troffer-diffuser" system developing from this concept has had increasingly widespread acceptance.

But where do we go from here?

There is still a great deal of pioneering to be done. In realistic terms, the "merger" of the lighting and air-conditioning industries insofar as office lighting and air distribution is concerned, is only an indication of what the future holds in store.

Further integration in the ceiling plane will be difficult, but the first step has been taken, making it a natural and continuing goal. An increasing amount of coordination will be needed between the lighting and air conditioning industries, from manufacturers on down, to keep this goal alive. Looking further into the future, it is not inconceivable that coordination may be necessary with one or more other industries.

Architects are finding that modular concepts of construction are not only more functionally efficient, but are reducing costs in the face of steadily rising costs of construction in general. The battle to keep these general costs in line will affect manufacturers of all products found in both horizontal and vertical planes. That effect will be a steady force toward product integration, and thus coordination between the manufacturers producing them.

The lighting industry must be aware of this trend, it must continually examine the course of the trend, and it must plan ahead to meet it.

RADIANT CONTROL of lighting heat loads

Laboratory studies were made to measure the heat transfer and lighting characteristics of water-cooled radiant luminous panels for the control of the heat loads of the lighting system. These tests have led to the development of an interesting radiant ceiling system for combined lighting and cooling, described here.

By GERSHON MECKLER
JOHN S. HICKMAN

All trends in building design today are aimed at producing a building interior which is as comfortable as the most desirable outdoor location. Of all the factors needed to produce this environment, lighting and air conditioning are the most important.

Modern lighting practice calls for illumination levels which result in quick, accurate and comfortable vision. In recent years there has been a growing awareness of the role lighting can play in raising productivity, decreasing errors and spoilage, and improving the general morale of the worker.

Heat from Higher Lighting Levels

All electric sources, regardless of type, generate heat in relation to the number of watts consumed. With today's light sources, higher concentrations of electrical energy are inevitable with higher lighting levels. The increased heat that results must be removed or neutralized before it affects occupant comfort or reduces the efficiency of the mechanical and electrical parts of the systems serving the area. Furthermore, it is desirable to achieve this objective with minimum expenditures of energy, equipment and space.

These new levels of illumination have created a challenging

Authors: Mr. Meckler is a Consulting Engineer, Meckler Engineering Co., Toledo, Ohio, and a member of the IES Committee on Lighting and Air Conditioning. Under the auspices of the Inland Steel Products Co., he designed the laboratory radiant luminous ceiling installation and conducted the test program described in the paper. Mr. Hickman was responsible for coordinating the program for Inland Steel Products Co., Milwaukee, Wis.

problem for the architect and engineer. The use of higher lighting levels has altered the entire economic picture with regard to air conditioning systems removing the heat introduced by lighting systems. Studies indicate that in an office building provided with 100 footcandles of general illumination, the lighting load accounts for approximately 42 per cent of the total air conditioning requirements. If the footcandle level is increased to 400 footcandles, the lighting accounts for approximately 72 per cent of the load. Obviously this heat must be removed, and it is sometimes impractical to remove the heat quantities produced by high-level lighting installations with conventional air distribution systems.

Integration of Building Systems—Products

The over-all interaction and combination of the major items listed below constitute the design factors in the control of total environment.

1. *Surroundings*—The size of the room, the furniture within, the color and material placed on the walls, floor and ceiling, and their relationships to each other, can have either a pleasing or an irritating effect.

2. *Light*—The illumination of a room, lighting levels, source, area of source, contrast, etc., is a most important factor.

3. *Air Conditioning*—The application of adequate air conditioning involves many factors and their relationships and interaction. Air is controlled by its:

(a) Temperature—level, location of control source, fluctuation.
(b) Humidity—level, location of control source, fluctuation.
(c) Movement—direction, speed, range of speed, fluctuation, part of body affected.
(d) Foreign matter—dirt concentration, pollens, carbon dioxide concentration.
(e) Odor—type, quality and amount.
(f) The interaction of the various factors and the result of the total action on the body.

4. *Radiation*—The effects of heat sources and sinks upon human comfort.

5. *Sound*—Type, complexity, frequency, whether continuous or intermittent, range or amplitude, relation to environmental or surrounding sound. The sound imposed in an area occupied by people can have a tremendous range of influence from an environmental standpoint.

The need to plan ahead for change creates varied and complex technical problems for the architect. The degree of success in achieving this goal is dependent upon the development of paralleling the service systems occupying the horizontal floor plane with the environmental control system established at the ceiling plane. The ceiling plane contains the environmental stabilizing acoustical, lighting and air conditioning elements. To achieve flexibility in the placement of these elements, they must be integrated on an interchangeable modular basis.

Conventional methods of building design, to satisfy current lighting loads and building occupancy needs, require the use of extensive space for ductwork, mechanical and electrical equipment. Considerable savings in building volume may be gained by integrating the structure with the environmental needs. It is for this reason that the various systems within the building (mechanical, electrical, structural) must be designed so that they function as integral parts of each other.

The creation of total environment can only be achieved through the integration of the mechanical, electrical and structural systems. No longer can these systems be considered independently of each other. The selection and design of each system must be developed simultaneously. The interaction of building systems requires that successful building products which serve as components of building systems must be designed and developed as a function of the systems designer. Therefore, building product design should be approached from the viewpoint of system integration.

Building integration may be static and/or dynamic. Static integration means that building system components are designed to be physically integral with each other without affecting their related system energy requirements. Dynamic integration, however, can be achieved by the design of dual purpose products which are common to two or more building systems, permitting the direct interaction of system energies in such a way as to increase the efficiency and/or reduce the net energy requirements of the integrated building systems.

Benefits of Integrated Ceiling Systems

Consideration of ventilation and radiant cooling systems integral with the lighting design, offers a number of potential advantages:

1. From an air conditioning standpoint, such a system offers the possibility of substantial heat reduction in rooms so that heat is removed before it becomes a factor in occupant comfort. The system also reduces the tonnage requirements and quantity of air (cfm) required for regulating the heat in occupied spaces.

2. The control of this heat, for use in cold weather or evacuation in warm periods, introduces the potential application of lighting as a heating system. Such a system might be used alone or with other systems.

3. The prevention of uncontrolled heat buildup in the lighting system induces ambient conditions more favorable for highly efficient operation of fluorescent lamps and ballasts.

4. An estimated saving of 50 cents per square foot of conditioned space associated with air distribution ductwork.

5. An estimated savings of 50 cents per square foot of conditioned space associated with central station air conditioning apparatus.

6. An estimated saving of 30 per cent in annual mechanical system operating cost.

7. An estimated architectural saving of five per cent in building volume and 50 per cent in the space which is usually allocated for mechanical equipment.

Adverse Effects of Nonintegrated Lighting System

Heat build-up within the luminaire may become substantial with the convection-conduction heat and the ballast load initially trapped in the unit and a portion of the radiant energy absorbed by the luminaire surfaces. This confinement of heat will also increase the temperature of the ceiling and ceiling cavity. If the build-up is allowed to continue, the luminaires and adjacent ceiling areas become "secondary heat sources," the heat being carried into the occupied parts of the room by convection or re-radiation to cooler objects and surfaces.

Radiant Air System

Luminaires, radiant and/or radiant acoustical panels offer the opportunity for integrated control of space and environment. Use of water-cooled systems also implies a reduction in building volume and material requirements when water tubing is used in place of bulky air ducts. It should be remembered, however, that water cooling does not eliminate the need for air in a room, since minimum ventilation air requirements must be maintained.

An analysis of the thermodynamic requirements of interior lighting systems demonstrated that radiant luminous ceiling and/or radiant water-cooled troffers as an integral component of the radiant air system, offer great potential in providing a dynamically integrated heating, cooling and lighting system.

The radiant air system is an (air-water) system arranged to utilize radiant heat transfer, convection heat transfer, and latent heat removal by means of chemical dehumidification. Fresh dehumidified air is introduced into the occupied space to provide ventilation and remove latent heat. A minimum amount of outside air is filtered and dehumidified by means of a chemical dehumidifier which brings air into contact with a hygroscopic solution. The solution removes or adds moisture in amounts as required. Outside air for ventilation purposes is dehumidified to a lower than conventional absolute humidity level and then is mixed with return air from the space to provide proper space latent heat control. The total mixed air is then sensibly cooled to the desired discharge temperature at the proper absolute humidity level. The total air is then distributed by means of unzoned vertical ducts located in shafts at the core of the building.

At the ceiling of each floor, horizontal header ducts extend from the vertical shaft ducts and distribute air to the cellular steel air floor. The cells in the floor act as branch ducts which distribute air through the floor to diffusers serving the occupied space. The supply air temperature to the space is fixed and does not vary as a function of the space load. Sensible cooling for the occupied space can be provided by means of radiant water-cooled troffers or a radiant luminous ceiling such as was developed and tested, as will be described later in this paper.

Condenser Water Heat Pump Circuit

The radiant air system being an "air-water" system can effectively utilize available heat generated by the lighting system to help provide the heating requirements during cold weather. The system is arranged to heat pump and transfer the light heat gains from the integrated radiant ceiling system to the air preheat coils in the air handling systems. The economies of the heat pump cycle are extremely significant.

With the requirement for simultaneous heating and cooling in different parts of the same building, it is advantageous to use the heat rejection from the refrigeration condenser, provided the level of the heat source is usable. For every 12,000 BTU/hr removed by the refrigeration chiller, approximately 15,000 is available at the condenser. By resetting the condenser leaving water temperature to approximately 120°F, energy becomes available for tempering ventilation air, as well as heating perimeter occupancy zones.

Cellular Air Floor Integrates Structure With Environment

The radiant air system utilizes cellular air floor as an integral component of the mechanical-structural-electrical and lighting systems. As a structural member, cellular air floor is a load bearing subfloor. As a component of the building electrical power system, it serves to provide raceways for equipment, lighting, signal, telephone, and security services. As a component in the mechanical system,

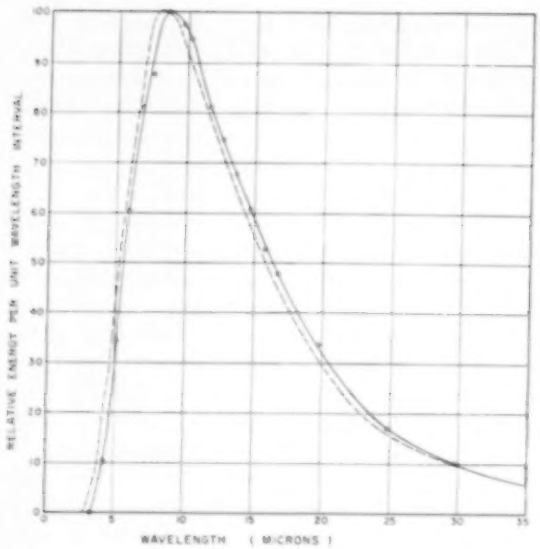


Figure 1 (left). Infrared energy distribution of slimline and 1500-ma fluorescent lamps. Solid line indicates slimline lamp (45°C); dotted line, 1500-ma lamp (65°C).

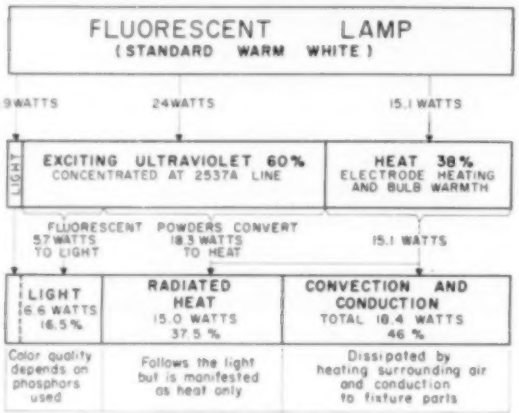


Figure 2 (above).

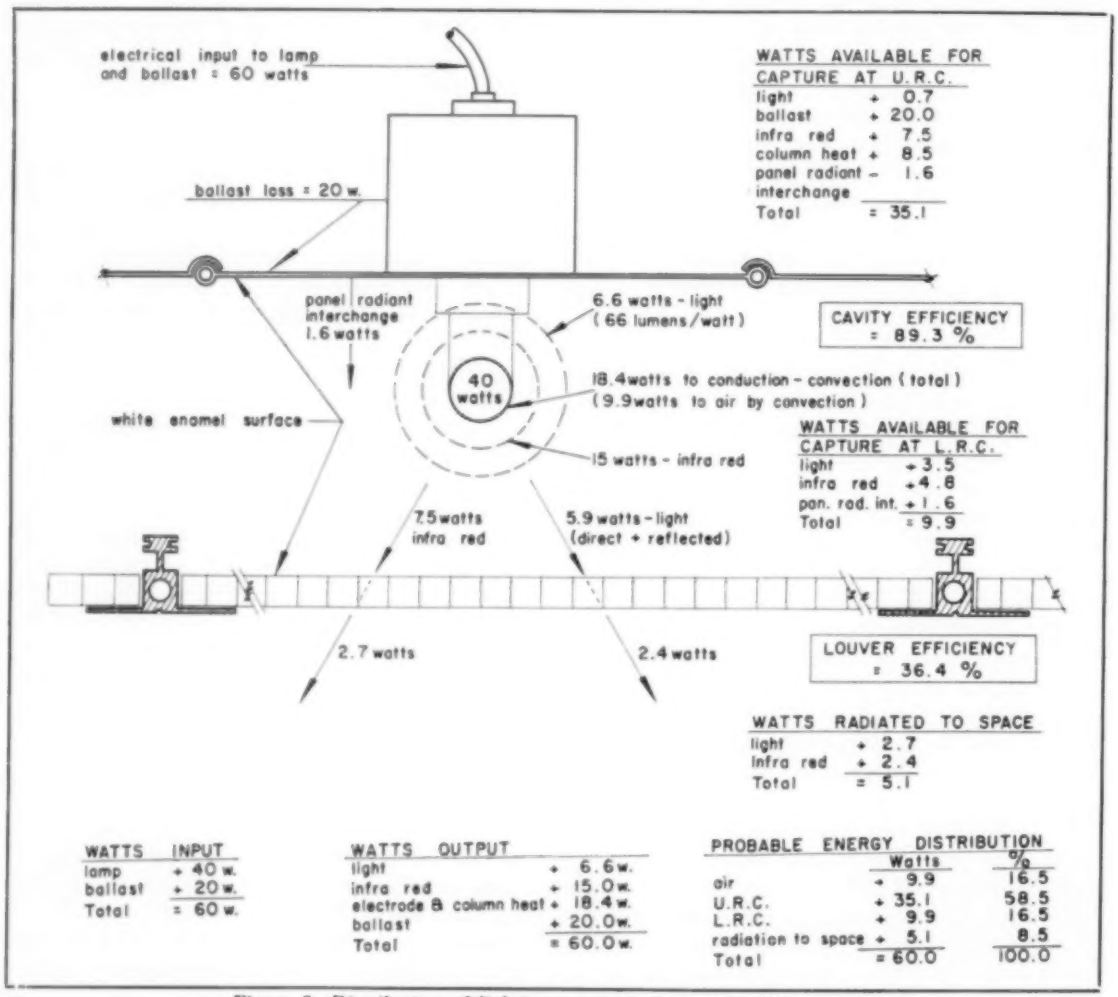

electrical input to lamp and ballast = 60 watts
ballast loss = 20 w.
WATTS AVAILABLE FOR CAPTURE AT U.R.C.
light + 0.7
ballast + 20.0
infra red + 7.5
column heat + 8.5
panel radiant interchange – 1.6
Total = 35.1
panel radiant interchange 1.6 watts
6.6 watts - light (66 lumens/watt)
CAVITY EFFICIENCY = 89.3 %
40 watts
18.4 watts to conduction - convection (total)
(9.9 watts to air by convection)
white enamel surface
15 watts - infra red
WATTS AVAILABLE FOR CAPTURE AT L.R.C.
light + 3.5
infra red + 4.8
pan. rad. int. + 1.6
Total = 9.9
7.5 watts infra red
5.9 watts - light (direct + reflected)
2.7 watts
2.4 watts
LOUVER EFFICIENCY = 36.4 %
WATTS RADIATED TO SPACE
light + 2.7
Infra red + 2.4
Total = 5.1
WATTS INPUT
lamp + 40 w.
ballast + 20 w.
Total = 60 w.
WATTS OUTPUT
light + 6.6 w.
infra red + 15.0 w.
electrode & column heat + 18.4 w.
ballast + 20.0 w.
Total = 60.0 w.
PROBABLE ENERGY DISTRIBUTION
Watts
%
air + 9.9 16.5
U.R.C. + 35.1 58.5
L.R.C. + 9.9 16.5
radiation to space + 5.1 8.5
Total = 60.0 100.0

Figure 3. Distribution of lighting energy in louvered ceiling system using 40-watt 48T12 slimline lamps with single lamp ballast.

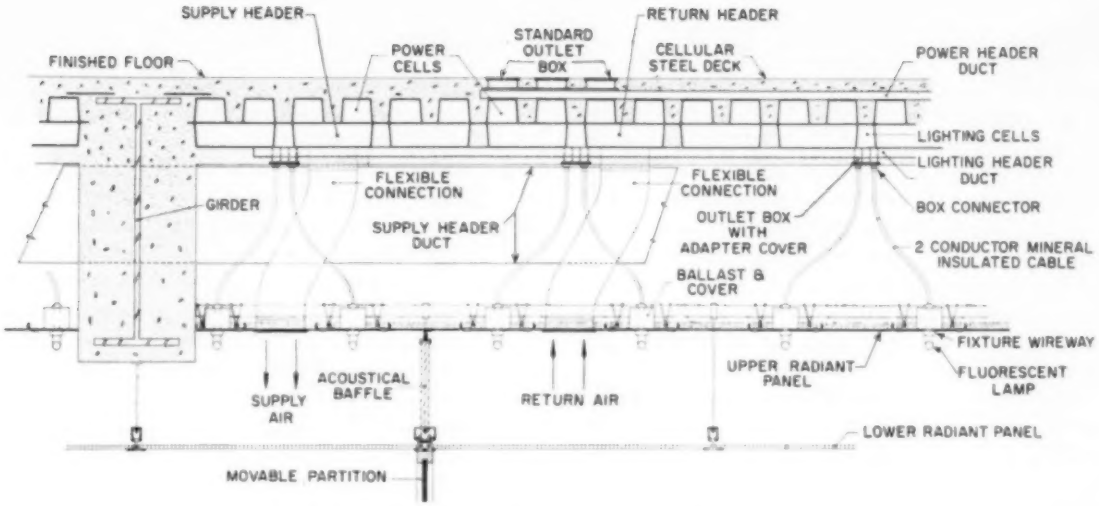


Figure 4. Integrated louvered ceiling—cellular floor arrangement.

ESTIMATED SYSTEM DESIGN FACTORS
LIGHTING - THERMODYNAMIC REQUIREMENTS

LUMINAIRE TYPE	LAMP SPACING	NUMBER OF LAMPS 8'-0"	NUMBER OF LAMPS 6'-0"	NOMINAL FC.	RESULTANT FC.	LUMENS PER WATT	WATTS/SQ. FT. INPUT LTG.	WATTS/SQ. FT. INPUT EQUIP.	WATTS/SQ. FT. INPUT TOTAL	WATTS/SQ. FT. TO SPACE LTG.	WATTS/SQ. FT. TO SPACE EQUIP.	WATTS/SQ. FT. TO SPACE TOTAL	CFM PER SQ. FT. AIR	SUPPLY AIR TEMP °F	LOWER PANEL TEMP.	UPPER PANEL TEMP.	BTU/HR. REMOVED UPPER PANEL	BTU/HR. REMOVED LOWER PANEL	BTU/HR. REMOVED SUPPLY AIR	BTU/HR. REMOVED RETURN AIR	THERMAL LOAD DISTRIBUTION % ON AIR	% ON UPPER PANEL	% ON LOWER PANEL
SLIMLINE	1'-6"	38	1178	100	90	30.0	0.0	2.0	10.0	1.5	2.0	3.5	0.6	69°	68°	71°	16.0	14.6	3.9	3.0	18.4	42.6	39.0
HIGH OUTPUT	1'-6"	38	1178	150	141	31.5	11.7	2.0	13.7	2.2	2.0	4.2	0.6	66.0°	67°	71°	23.0	10.9	5.5	4.3	19.8	46.2	34.0
POWER GROOVE	1'-6"	38	1178	200	234	48.5	22.4	2.0	24.4	4.2	2.0	6.2	0.9	64.0°	65°	71°	40.0	21.7	10.2	8.3	21.8	52.8	25.4
SLIMLINE	1'-0"	57	1788	150	142	30.0	12.0	2.0	14.0	2.3	2.0	4.3	0.6	66.5°	67°	71°	24.0	17.0	5.3	4.4	19.5	47.1	33.4
HIGH OUTPUT	1'-0"	57	1758	300	310	51.5	17.3	2.0	19.3	3.3	2.0	5.3	0.9	64.5°	65°	71°	34.0	21.1	7.0	6.4	19.6	49.6	30.8
POWER GROOVE	1'-0"	57	1788	400	375	48.5	33.0	2.0	35.0	5.2	2.0	8.2	1.5	62.4°	65°	71°	66.0	24.3	20.4	12.3	23.6	53.6	19.8

NOTE: COEF. OF UTILIZATION 0.36 MF -65%
I.E.S. LIGHTING HANDBOOK DATED 1959

it provides uniform distribution of supply and return air to the conditioned space.

The system makes possible the use of the cellular floor to reduce building floor to floor height. Between floors, the depth of the beam plus the return air duct establishes the ceiling height when this dimension is greater than the depth of the girder. Cellular floor used for distribution with an "all-air" type system in modern buildings does not have capacity to satisfy combined supply and return air, as well as electrical requirements. To provide needed electrical availability in the floor for most conventional office requirements, it has been found necessary to leave return air distribution out of the cellular floor. With the radiant air system, however, only the depth of the girder establishes the ceiling height.

Selective Absorption of Infrared Radiation

Referring to Fig. 1, the normal infrared radiation curve for a 48T12 lamp operating at a surface temperature of 45°C peaks at approximately 10 microns with the greatest amount of energy occurring between 3 and 35 microns. Tests with a white enamel finish indicated complete absorption of infrared from 9 through 26 microns, while reflection was normal for that of a white enamel surface. Of all the colors, white enamel showed the greatest range of capture for infrared radiation, even greater than that for a black anodized finish. As a result of these preliminary tests, indications point to the practicability of distinguishing between visible radiation and infrared radiation at the upper and lower radiant panels. Radiant panel surfaces thus can act as efficient collectors for infrared radiation while reflecting light in the normal manner.

Based on data given in Figs. 1 and 2, the probable distribution of lighting energy in a louvered ceiling system using a 40-watt 48T12 slimline lamp with a single-lamp ballast is illustrated in Fig. 3.

Radiant Luminous Ceiling

The radiant luminous ceiling illustrated in Fig. 4 is arranged with an upper radiant ceiling panel integrated with the lighting fixtures and a lower louvered radiant ceiling arranged to view both lighting and space load. In the building interior, conditioned air is supplied by means of diffusers

arranged in the upper ceiling; air is returned by means of return air registers located in the upper ceiling. The louvered radiant ceiling system removes heat load as well as heat ventilated in the occupied space. In addition, it serves as an efficient light diffuser controlling brightness. The electrical input to the lighting system required to produce a given illumination level, varies with the ceiling cavity dimensions, surface reflectances, the type of lamp and ballast used, and the character of the lighting diffuser.

The lower ceiling grid consists of an arrangement of water-cooled supporting tees and a heat transmitting light diffusing grid. The tees are arranged on a modular basis to provide maximum flexibility for future space changes, as well as temperature control changes. Each individual space module can have its own temperature control.

Interior areas are controlled by means of a space thermostat which modulates the temperature of the radiant panel water. This is an extremely significant development since it simultaneously provides visual and thermal comfort.

Reseach Program

A laboratory was constructed at the Inland Steel Products Co. in Milwaukee, Wis. to determine measurements of the heat transfer and lighting characteristics of radiant ceiling products used as components of the radiant air system. A metal enclosure (approximately 19 feet-6 inches by 27 feet by 11 feet-1-inch high) was erected in an existing plant facility to house the radiant air system test cell air conditioning equipment, water heating and cooling equipment, electrical panels, piping instruments and controls. The following are the results of a limited research program, prepared to demonstrate the feasibility of designing a luminous radiant ceiling system to remove the heat generated by the lighting system and to provide effective control of thermal load within the conditioned space.

The radiant ceiling panels tested were samples. The Lower Radiant Ceiling panels were fabricated by modifying a standard "honeycomb" luminous ceiling louver. The Upper Radiant Ceiling panels were fabricated to accommodate test cell dimensions and anticipated heat captures. The lighting fixtures also were adapted for cooling of individual ballasts. "URC" refers to the Upper Radiant Ceiling; "LRC" refers to the Lower Radiant Ceiling.

Test Cell

An 8-foot 6-inch by 12-foot test cell was erected with a wooden floor using wood wall studs and two-inch plywood. The interior plywood wall surface was completely sealed with a three-inch thickness of Fiberglas insulation. Two one-inch layers of rigid insulation were applied to the existing wooden floor to serve as the floor surface of the test cell. The test cell ceiling consisted of a three-inch cellular steel deck mounted 10 feet 5 inches above the finished test cell floor. The cellular deck was insulated with a three-inch-thick layer of rigid insulation on the top side and a two-inch-thick layer

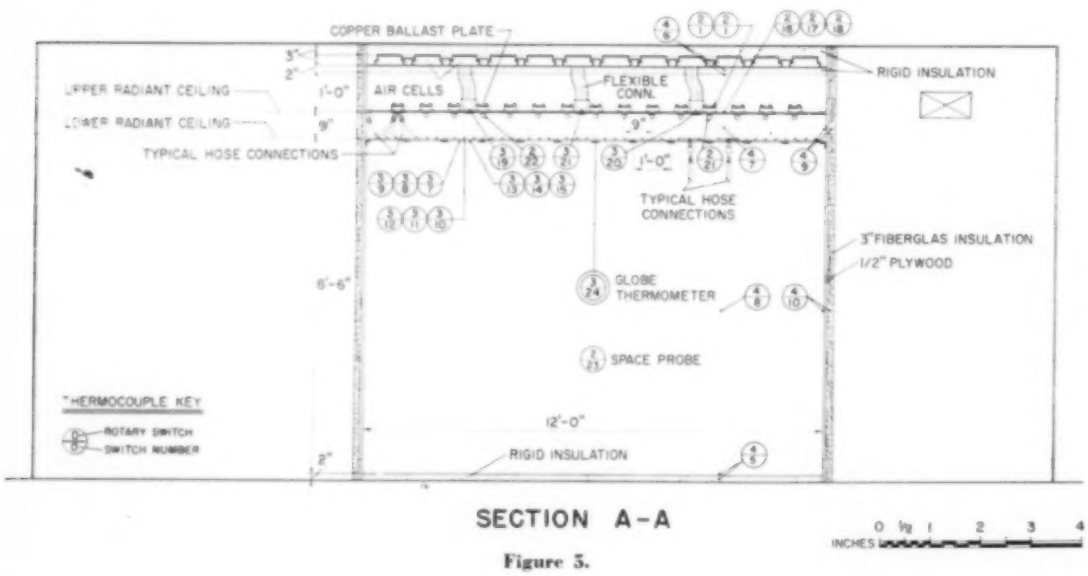


Figure 5.

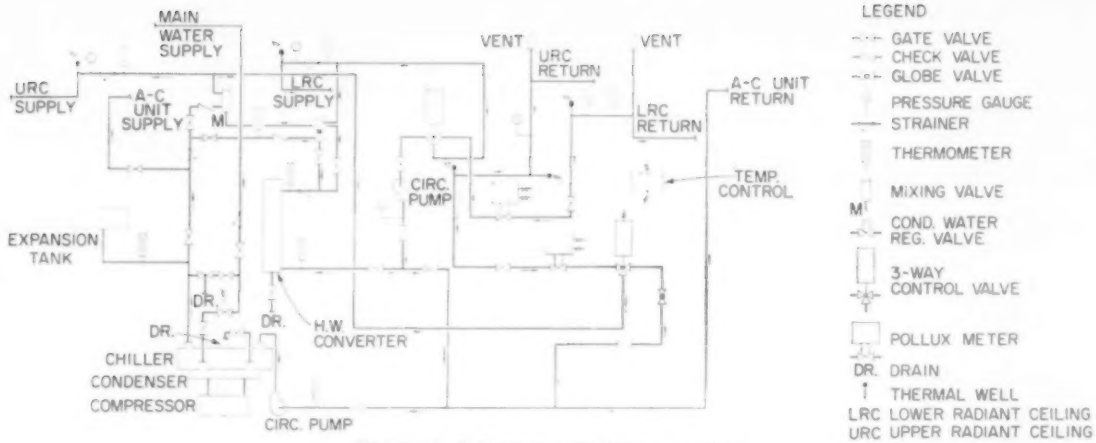


Figure 6. Laboratory equipment piping.

of rigid insulation on the under side. Fig. 5 shows a section view through test cell.

Test Equipment

The apparatus used for testing the Upper and Lower Radiant Ceiling systems consists of the following major pieces of equipment: a 3-ton Heat-X water-cooled refrigeration chiller, a 6-kw Chromulux electric hot water converter, a 600-CFM Acme blower-coil assembly, an electric Indeeco blast coil, two circulating pumps, two Pollux meters, two Minneapolis-Honeywell automatic three-way mixing valves, piping and associated controls, etc., all as illustrated in Fig. 6.

Referring to Fig. 6, and starting at the chiller outlet, chilled water is supplied to the blower-coil unit and to the cold water inlet on each of two manually adjustable Type "DV" Sarco water blending valves. Hot water leaving the converter is supplied to the hot water inlet of the water blending valves. Mixed water of predetermined temperature is supplied respectively to the LRC and URC supply headers supported on the outside wall of the test cell enclosure. Water flows through rubber hose connections to each radiant panel. A manual valve is provided on the inlet and return of each individual panel to permit isolation and flow control. Water from each of the individual radiant panels passes to its respective return header which is arranged for "reverse" return flow in order to insure uniform water distribution in each ceiling.

Water from the URC return header flows to the URC Pollux meter and then to URC three-way mixing valve which regulates flow automatically by holding return water temperature constant. From here return water flows to the inlet of the chiller recirculating pump, etc. Water from LRC return header flows to the LRC Pollux meter and then to the LRC three-way mixing valve which is automatically controlled by space temperature within the test cell. On both URC and LRC headers chilled water is by-passed to its respective three-way mixing valve to provide constant flow in the system and variable flow in the radiant panels. Return water leaving the LRC three-way mixing valve flows to an in-line circulating pump which delivers return water either to the hot water converter or to the inlet of the chiller recirculating pump.

Radiant Ceiling Panels

The Upper Radiant Ceiling panel is constructed of Olin-Mathieson "Roll Bond" in which two parallel serpentine coils are integrally formed as shown in Fig. 7. The panels were mounted between lighting fixture assemblies to form a continuous finished ceiling.

The Lower Radiant Ceiling panels are constructed of "honeycomb" aluminum louvers, $\frac{3}{8}$-inch across flats, approximately five mills thick and 0.650 inch deep, cut and framed to test cell dimensions. Individual hexagonal louvers formed by continuous elements are joined at intervals across the width of each panel by epoxy resin adhesives.

Three parallel $\frac{3}{16}$-inch diameter water tubes are bonded to the panel by means of a solder pressure fit. The LRC panels were fabricated using each hexagonal element running below a water tube as a mold for solder. The solder forms a good bond to the copper tubing and, upon solidifying, forms a tight pressure fit against the lateral faces of the hexagonal mold.

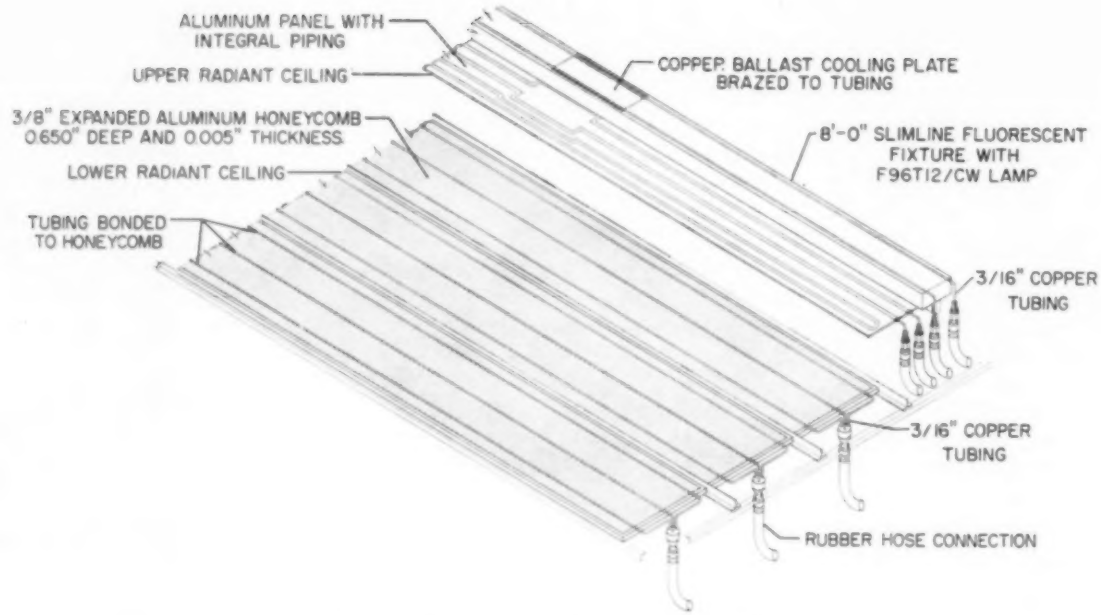

ALUMINUM PANEL WITH INTEGRAL PIPING
UPPER RADIANT CEILING
3/8" EXPANDED ALUMINUM HONEYCOMB 0.650" DEEP AND 0.005" THICKNESS
LOWER RADIANT CEILING
TUBING BONDED TO HONEYCOMB
COPPER BALLAST COOLING PLATE BRAZED TO TUBING
8'-0" SLIMLINE FLUORESCENT FIXTURE WITH F96T12/CW LAMP
3/16" COPPER TUBING
3/16" COPPER TUBING
RUBBER HOSE CONNECTION

Figure 7. Laboratory luminous radiant ceiling.

Copper tubes are arranged perpendicular to all aluminum elements that are continuous across the width of each panel.

Test Procedure

Each of the runs illustrated in this report was taken under steady state conditions. These were achieved by adjustment of the refrigeration chiller to operate continuously and by varying the electrical input to the hot water converter to bring the system into balance. Having established a specific flow rate in the Upper and Lower Radiant Ceilings, the LRC and URC three-way mixing valves were secured at a fixed valve position and the system was allowed to come into equilibrium.

To indicate any unbalance either in the test cell or back at the equipment, reading of all thermocouples located in each supply and return water header were monitored at designated time intervals during the course of each run. A run was begun only after monitoring of selected temperatures within the test cell indicated steady state operation.

Test and Recording Apparatus

Measurements of air velocity were made by means of a portable Alnor direct reading resistance type anenometer whose probe was inserted into openings in the ductwork. Flow measurements were made by means of the Pollux meter which records both gallons and BTU's. The Pollux meter integrates temperature difference and flow rate measurements to indicate the number of BTU's removed between each supply and return water header.

In order to obtain a more accurate measurement of heat removed, thermocouple readings of panel water supply and return headers taken during each run were averaged, and only the flow measurements from the Pollux meters were used to calculate the rate of heat removal.

All temperatures were measured by means of a Leeds Northrup laboratory millivolt potentiometer. The cold junction adjustment was used in taking all temperatures. This instrument has a sensitivity of 22 millivolts per degrees Fahrenheit with copper-constantan leads.

Experimental Data

In all, seven runs were made to evaluate (1) the operation of the Luminous Radiant Ceiling System with and without separate cooling of lamp ballast or operation of the Upper Radiant Ceiling; and (2) the operation of the Lower Radiant Ceiling and Upper Radiant Ceiling individually. Runs No. 1 and 2 describe the operation of the Luminous Radiant Ceiling System with all components operating; run No. 3 describes the operation of the Luminous Radiant Ceiling System with all components operating except for separate cooling of the lamp ballast; runs No. 4 and 5 describe the operation of the Luminous Radiant Ceiling System with all

components operating except the Upper Radiant Ceiling; run No. 6 describes the operation of the Lower Radiant Ceiling only, and run No. 7 describes the operation of the Upper Radiant Ceiling only without separate cooling of the lamp ballast.

Summary of Results

Analysis of Runs No. 1 to 7 indicated that the experimental data taken all checked to within at least 90 per cent of a complete heat balance.

- The Lower Radiant Ceiling panel load capture during the tests varied from 27.4 to 37.0 BTU/hr-ft^2 with mean circulated panel water temperatures ranging from 60.3°F to 66.4°F.
- An increase of approximately 40 per cent in load capture resulted when the Upper Radiant Ceiling panels were inoperative. Ballast cooling does not appear to have much of an effect on the Lower Radiant Ceiling performance.
- An increase of approximately 5 per cent capture resulted with forced air circulation, indicating an increase due to reconvection of air load to the Lower Radiant Ceiling panels.
- The Lower Radiant Ceiling heat removal capacity appears to vary inversely with mean circulated panel water temperature but is not significantly affected by panel water flow rate. For example, comparing the Lower Radiant Ceiling performance in Runs No. 4 and 6, with an increase in panel water flow rate of 36 per cent, a 4.2°F rise in mean circulated water temperature resulted in a 6 per cent drop in heat removal capacity. Comparison of Runs 4 and 5 at the exact same flow rate indicated that a 1.3°F. rise in mean circulated water temperature resulted in a drop of 7 per cent capacity.
- Analysis of the Lower Radiant Ceiling temperature gradients indicates that these panels tend to remove heat uniformly across their surface.
- The Upper Radiant Ceiling load capture varied from 37.6 to 50.9 BTU/hr-ft^2 with mean circulated water temperatures ranging from 65.9°F to 69.2°F.
- Heat removal capacity was reduced approximately 10 per cent with ballast cooling shut off. Variations in mean circulated water temperatures in the range tested appear to have less effect than does panel water flow rate.
- In those runs in which air is introduced at approximately 0.55-cfm per square foot of floor area, such as Runs No. 1 to 3, air appears to reconvect most of its heat pickup to the Upper Radiant Ceiling and the Lower Radiant Ceiling. Only in Runs No. 4 and 5, with the Upper Radiant Ceiling panels inoperative, does air account for from 2 per cent to 3 per cent of the total space heat removal.
- During the tests, the measured test cell space temperature varied from 67.9°F to 81.5°F. In all runs in which the Lower Radiant Ceiling was operative, the measured test cell space temperature never exceeded 74.4°F.
- With respect to dynamic integration, test data indicate that the building fluorescent lighting system which generates both light and heat by radiation normally in a 1-to-5 ratio excluding ballast, can be made to improve its light producing efficiency by radiant control of the bulb surfaces. Laboratory tests with an integrated luminous ceiling indicated that proper control of the lower radiant ceiling would result in an increase of 3.5 per cent in the normal measured illumination at desk level, and a simultaneous reduction of 5 per cent in the electrical input to the lighting system. The interaction of building system energies demonstrates that dynamic integration of lighting and air conditioning systems is possible when load sources are controlled by mechanisms (such as radiation) which directly affect their efficiency.

The practical consequences of the marriage of mechanical-electrical-structural-architectural building systems are far reaching The major air conditioning problem in many of today's modern buildings has been created by thermal load associated with providing higher levels of illumination. In addition, research indicates that lighting systems placed in an environment in which they cannot be maintained at a proper operating temperature have noticeably reduced luminous efficiencies. The radiant air system integrates lighting components such as the water-cooled radiant lighting troffer and/or radiant luminous ceiling with other building systems to improve the luminous efficiency of a lighting system and to remove a substantial portion of the associated thermal load directly at its source without circulating excessive quantities of air or requiring increased space between floors for duct work and/or equipment.

Credit—Dual-Purpose Cellular Floor

All research and development discussed in this article was carried out under the auspices of Inland Steel Products Co.

As structural members, Inland Steel Products Co. H_1F and N_1F cellular floor sections are load-bearing subfloors. As a component of the building electrical system Inland Steel Products Co. N_1F cellular floor serves to provide raceways for power, lighting, signal, telephone and security services. As a component of the mechanical system, H_1F cellular floor serves to provide uniform distribution of supply and return air to the conditioned space.

ACOUSTICAL in designing

A BUILDING in any period of architecture is a synthesis of many ideas. The priority of these ideas expresses the thinking of the period in which the building is erected. In this age of technology, with the constant development of new ideas and building techniques, buildings have grown from being mere shelters into complex envelopes containing tremendous amounts of equipment which can provide people with a carefully controlled environment. Ideally, the envelope and its equipment control the environmental factors of heat, light, ventilation, and sound so as to provide a satisfactory, total environment in which people can carry on their activities in the best possible manner.

This priority of mechanical equipment in our thinking today is sometimes an important expressive element. For instance, in the United Nations Secretariat building the floors completely devoted to mechanical equipment are clearly expressed on the facade. More often, however, structure is the most important expressive element and mechanical equipment is hidden behind false facades and hung ceilings. Though this equipment may sometimes occupy 20 per cent of the total volume of a building and may amount to 50 per cent of the total cost, the traditional approach often does not express this important fact. It is a problem not honestly faced, and the result is often chaotic.

Why Integrate?

Perhaps the chaos of the hidden maze of services above a suspended ceiling is a true expression of the confusion that exists in this rapidly developing area of building technology. Too often, for instance, the ventilating equipment and ductwork are crammed into a space already confused by trusses, pipes and lighting fixtures, each element neglecting and trying to avoid the other in a needlessly inefficient manner. All of these functions have been considered more or less independently of one another and often this independent consideration of any one of the elements that go towards making up the total environment works to the detriment of one or more of the other elements. This is why we see so many buildings that are well ventilated but poorly lighted, or well lighted, but with poor acoustics, etc. Thus, there is a growing need for study of the integration of these services.

To provide this efficient integration of the elements which control sound, light, heat and ventilation requires some understanding, on the part of the building designer, of the basic physical principles in each of these disciplines. The principles of how light, heat, and sound behave do not change; it is our understanding of these principles and the application of techniques for controlling these factors that grows. In the building industry, sound control, *i.e.*, acoustics, is perhaps the most recently developed technique. Today, the engineer should work with a background of knowledge of how sound behaves and how the mechanics of fulfilling other needs can best adapt to acoustical requirements. Just as the heating or lighting engineer must have a basic understanding of structure, he should also have a basic understanding of acoustics. Yet, too many design engineers involved with buildings know little about the physics of sound. Misconceptions and old wives' tales die hard and the feeling that acoustics is a matter of luck—an unpredictable phenomenon—rather than a branch of physics which is to a large extent predictable and measurable, is all too common.

The Nature of Ceilings

During the past few decades more and more of the elements which provide light, heat and ventilation have moved up into the ceiling area—whether this be an exposed structural ceiling or a suspended ceiling. Most provisions for sound control have also been concentrated in the ceiling area. As we shall see, the reasons for this are inherent in the nature of a ceiling—thus the validity of examining the nature of a ceiling in understanding the importance of acoustics in the design of an integrated ceiling.

A ceiling is unique in many ways. It need not

AUTHOR: Bolt, Beranek and Newman Inc., Consulting Acoustical Engineers, Cambridge, Mass.

CONSIDERATIONS
integrated ceilings

By J. A. CURTIS

be structurally strong. The materials used do not have to take the abuse that walls and floors are subjected to. It is the most clearly visible surface in any room. It can conceal a large continuous volume housing the ducts, wiring, piping, etc., serving an entire floor. It can be held in place by gravity, thus making it easy to remove for maintenance. It can be an acoustical or thermal barrier, a partially-open visual barrier, a hard sound reflecting surface or a fuzzy sound absorbing surface. It can also be one large air diffuser or one large lighting fixture, a grille behind which lights, air supply and return air ducts, heating elements and sound reflectors and absorbers can be hidden, or it can be a flexible combination of all these things. Unlike floors or walls, ceilings can be designed without concern for furnishings or people.

How Sound Behaves

To avoid the acoustical pitfalls which can make an integrated ceiling design an acoustical disaster, a basic understanding of what sound is and how it behaves is essential. For example, a typical acoustical problem recently confronted an architect who had just completed a multi-story office building. The ceiling was an ingenious system which provided recessed strip lighting fixtures and strip perforated air diffusers three or four feet on centers, in a continuous acoustic tile ceiling. The space above the ceiling acted as an air supply plenum. Louvered openings in the doors provided a path for the return air exhaust via the corridor. (This alone presented a room-to-corridor privacy problem, but the main problem resulting from the integrated ceiling design was the lack of privacy between rooms.) Partitions which terminated against the continuous ceiling could easily be moved in a flexible layout. Thus, each area was assured of adequate heat, light and ventilation. However, the trough lighting fixtures, the perforated strip diffusers and the light-weight acoustic tiles provided efficient room-to-room path for sound over the partitions, through the plenum. With practically no background noise level the rooms were so quiet that it was possible to hear conversations from offices two or three doors down the hall!

This example is typical of many cases where a basic appreciation of the behavior of sound energy would have saved the owner much trouble and money in providing tenants with well-ventilated and lighted office space, along with a satisfactory acoustical environment.

A satisfactory acoustical environment is one in which the character and magnitude of all noises are compatible with the satisfactory use of the space for its intended use. In practical terms, as in a cafeteria, for example, it may simply mean reducing the level of the sound made within the space by providing sound absorbing material. In an auditorium, this may mean making the sounds coming from the stage loud enough, by providing adequate sound reflecting surfaces to reinforce the direct sound heard by the audience. Finally, it may mean the reduction of intruding sounds, such as speech coming from an adjacent office, by providing a satisfactory barrier between rooms.

Though a certain level of noise may be acceptable in a large office area where many people are typing and talking, this same noise level might be distracting in a small private office or library. However, the magnitude or sound level is only one factor in determining a satisfactory acoustical environment. The character, *i.e.*, the duration and

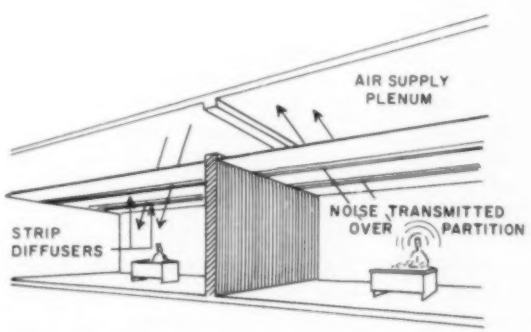


Figure 1. Direct communication between rooms via the plenum space.

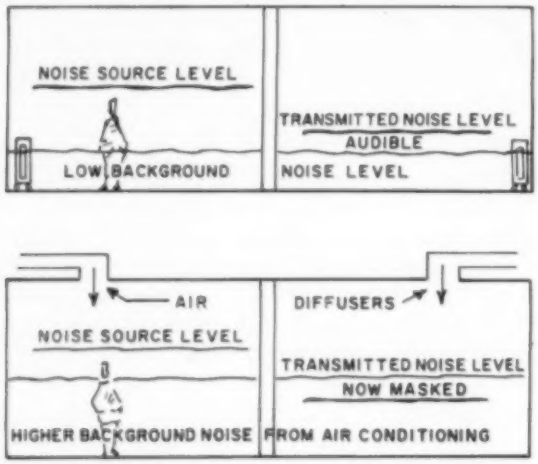


Figure 2. Masking effect of increasing background noise.

frequency range of the sound, is also important; a low-level, intermittent noise or a high-pitched sound can be extremely distracting, compared to continuous, bland background sounds. In fact, a moderate-level, continuous background noise level, evenly distributed throughout the frequency band is often less oppressive than "dead" silence. It can make a space seem quieter because it tends to "mask" the sounds from other activities. We have all had the experience of being in a room which seemed "quiet," only to notice how "noisy" it *has* been, when some piece of equipment is turned off. Suddenly, private conversations or typewriters in adjacent areas become audible, where they were previously not heard above the continuous masking noise. We see that certain sounds of a particular character and intensity may be actually desirable as a "masking" background noise; but we are, in general, concerned with (1) reduction of reflected sound by sound absorbing material; (2) reinforcement and direction of desirable sound by sound reflecting surfaces; and (3) the attenuation of intruding sounds by adequate barriers. It is through these measures that we can provide a satisfactory acoustical environment. A properly designed integrated ceiling plays an important role in all three areas, since it is an ideal surface for sound absorbing treatment, sound reflecting materials and it often forms an important barrier—over ceiling-high partitions—which must attenuate sounds between rooms.

Sound Absorption

The reverberant quality of a room is an important consideration in providing a satisfactory environment. All materials absorb some sound energy, dissipating, with each reflection, the total energy within the space. The more absorption there is, the more quickly the sound "dies out," thus the shorter the reverberation time and the "deader" the room.

Sound absorption in a room is provided to some degree by every surface. Curtains, rugs, upholstered furniture, people, acoustic tiles and blankets of fuzzy material all provide significant amounts of absorption. While a plaster ceiling may absorb only three per cent of the incident sound energy, an acoustic tile ceiling will absorb 60-90 per cent of the sound energy, depending on the particular material and its thickness. Sound waves in the air move into these porous materials and acoustical energy is lost in the form of heat by the frictional drag of air molecules on fibers in these materials. This frictional loss is the most common way in which sound energy is dissipated. Though losses by panel flexure in materials such as thin plywood, metal or plastics contribute to low frequency absorption, this is less significant since it does not compare in efficiency with the absorption provided over a wide frequency range by thick porous materials or thinner porous materials with a deep air space behind.

The presence of sound absorbing material will affect the level of noise in a room since the sound heard is made up of both reflected and direct sound. As we start to move away from the noise source in a room, the sound level drops off. Soon, however, the noise reaches a level which is fairly constant throughout the rest of the room, due to the multiple reflections which diffuse the sound throughout the room. Thus, by applying sound absorbing materials to the sound reflecting surfaces, the noise level, outside of the "near field" close to the sound source, will be reduced. Since the total amount of sound energy within the room is thus decreased, there is that much less sound which can be transmitted through the wall or ceiling into an adjacent room. However, *considerable* amounts of sound absorption within a space will only increase the noise reduction *between* rooms by the order of 4 or 5 decibels. Contrary to popular theory, the placing of sound absorbing material on a dividing barrier contributes little to the total noise reduction, since it usually contributes little to the imperviousness or mass of the barrier. However, sound absorbing material, within the space above a hung ceiling or in the air space of a double wall, *will* contribute somewhat to the total noise reduction by absorbing sound energy and preventing the propagation of sound waves within the cavity—similar to the effect of a glass fiber lining that is within a duct.

The most common sound absorbing ceiling materials are the factory finished prefabricated units. These can be combined with recessed lighting fix-

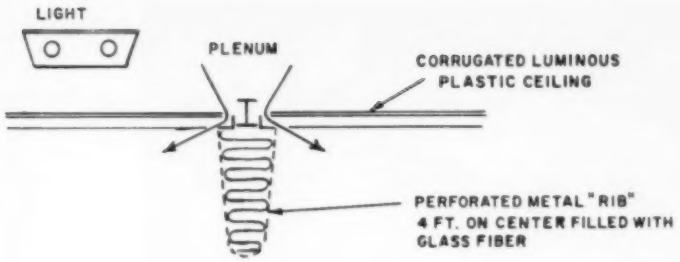


Figure 3. Provisions for light, heat, ventilation and sound control integrated in this luminous ceiling system.

tures and openings can be provided for air diffusers. The acoustical tile thus becomes a part of a ceiling which combines several functions, but this usually could not be called truly "integrated ceiling" since it is often a casual combination of elements, *not* a total unified design.

There are, however, some materials and equipments which in themselves combine two or more functions. It is these materials which point the way towards the design of a truly integrated ceiling which can provide ventilation, heat, light, sound absorption and reflection, as well as a barrier to intruding sounds. Certain translucent plastic luminous-ceiling sheet materials function as sound absorbing material, due to their carefully designed flow resistance properties. With this type of material, in combination with a large air space behind, the luminous ceiling itself becomes a sound absorbing element. There is also a slotted acoustical tile material which combines the functions of a sound absorber and an air diffuser. Air in the plenum above is introduced through the slots, at low pressure. (Neither of these materials provides much sound reduction between spaces.) One "integrated ceiling" system which combines light, air conditioning and acoustical absorption is the deep perforated metal fin. This fin is used as a supporting rib for a luminous ceiling. At the top edge, opened slots introduce air from the plenum above and the perforated fin is filled with glass fiber to act as a sound absorber.

A perforated metal pan ceiling with sound absorbing glass fiber batts laid on top is another method of combining several functions in a ceiling. Some areas can serve as perforated diffusers. Hardboard panels can be laid over other pans, providing a sound reflecting surface.

Acoustic plaster should be mentioned here as it is an increasingly popular way of providing a uniform surface with sound absorbing qualities, as well as a sound attenuating, fireproof barrier to the space above. Unfortunately, its sound absorptive qualities are often unpredictable, and its effectiveness is rapidly diminished if the pores are blocked up with paint. It can only be applied in relatively thin layers. Therefore, it is most effective in absorbing high frequencies which are often not the problem. When one remembers that sound waves in the mid-frequencies are a foot or two in length, it is obvious that a rough plaster surface or "acoustic paint" will have about the same effect on the sound wave as a thin reed has on a large ripple in a stream. However, the need for a uniform efficient sound absorbing material is more successfully met by a one-inch thick layer of porous sprayed asbestos. In this connection, the old but *still* occasionally tried myth that stringing wires across a ceiling will absorb and "break-up" the sound need not be analyzed, but it should be laid to rest!

Sound Reflection

In addition to the need for sound absorbing material which will reduce the reverberant quality of a room and reduce the level of undesirable sounds generated within the space, the integrated ceiling design must often provide a sound reflecting surface which can reinforce the sounds which the listener *wishes* to hear. Unobstructed by furniture or people, the ceiling becomes the most practical sound reflecting surface in a conference room, a classroom, an auditorium or a church.

In a small lecture room, it may be possible to understand a speaker though the ceiling is completely covered with a sound absorbing material and provides little reinforcing reflected sound. However, it is often easier for the speaker and

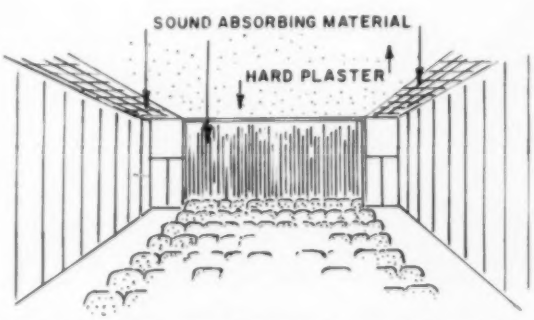


Figure 4. Hard center-ceiling area to reflect sound in a classroom or lecture room.

Figure 5. Loeb Drama Center grille ceiling with hard sound reflecting surface above. Mechanical equipment above acoustically "transparent" ceiling. (*Photo: Clemens Kalischer.*)

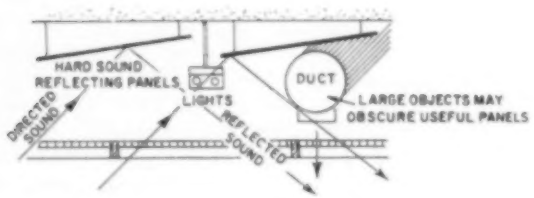


Figure 6. "Transparent" ceiling hides mechanical equipment and sound reflecting panels.

Figure 7. Frederick U. Conrad High School Auditorium coves face away from stage and ceiling surfaces directing sound towards audience. (*Photo: Louis Reens.*)

listener if a hard ceiling is present to act as a sound reflecting panel. A hard center area is usually adequate and the peripheral area may be covered with sound absorbing material to provide the required reverberation control.

Where a ceiling is high, as in a church, a pulpit canopy may be required. In an auditorium, suspended panels at the stage end of the room may serve the same function. Since it is usually desirable not to rely entirely on the use of a sound amplification system in any room where good hearing conditions are important, it is important to design a ceiling which will provide maximum reinforcement of the direct sound.

Any fairly heavy impervious material such as plaster, plywood, or a solid plastic luminous ceiling will reflect sound waves to a high degree. Conversely, a ceiling covered with a porous, fuzzy sound-absorbing material will provide very little useful reflected sound energy. The situation can be compared to the lighting situation: just as a matte black ceiling will reflect very little light, a fuzzy porous ceiling will reflect very little sound.

The designer is provided some freedom by the fact that some materials can provide an acoustically "transparent" ceiling behind which reflecting surfaces, lighting fixtures, ducts and the necessary amounts of sound absorption may be hidden. In order to be "transparent," however, the elements of the ceiling must be appropriately related to the wavelengths of the sound. Though music may cover the entire frequency range, in the speech range alone—approximately 200 to 5000 cps—the length of the sound waves varies from approximately five feet to three inches. An object with dimensions of less than half a wavelength will not be "seen" by the sound wave, but a larger object will interrupt and reflect this sound wave. Therefore, an open-weave fabric, a slat ceiling with 2- by 2-inch slats 10 inches on center, or a grid of 6- by 6-inch ribs, 5 feet on center for instance, will be virtually "transparent" whereas a grid or slat ceiling with larger members, more closely spaced, will be transparent only to the lower frequencies and will deflect and diffuse the shorter sound waves. (Sometimes a ceiling with large slats will give an audible "picket fence" effect by reflecting high frequency sounds off each slat, in rapid succession.)

With this in mind, it is apparent that an acoustically "transparent" ceiling must be *quite* open if the full range of frequencies is to pass through it on its way *to* the sound reflecting panels which will reflect the sound *back* through this "ceiling" towards the audience. We can also see that large ducts running in front of these panels, for instance, will cast "shadows" on the panels for all

but the lower frequencies but will reflect the sound back in unintended directions.

In the same way that small objects are not "seen" by long sound waves, small irregularities on a hard ceiling surface will not break up or diffuse sound waves except for the higher frequencies. Thus, for instance, a supposedly "acoustical" wood plank ceiling with thin saw cuts across its surface can hardly be of any acoustical significance.

In large auditoriums, a low flat sound reflecting ceiling will not usually provide the necessary directed diffusion of sound energy throughout the seating area. As in the case of light waves, the angle of reflection of sound waves is equal to the angle of incidence. Thus, the front half of the ceiling must be high enough and properly shaped to reflect sounds coming from the stage towards the audience —in particular, towards the central area. (In the front of the auditorium, people are close enough to hear the direct sound, and most of the sound reflected off the walls and rear ceiling area will reflect towards the people in the middle and rear of the room.) By drawing ray diagrams we can determine the correct slope of the ceiling to direct the sound as required.

In order to integrate the openings for ventilation and lighting with the shaping of the ceiling, auditorium ceilings are often broken into several stepped planes with coves extended across the room, facing the stage—thus not visible to the audience. Unfortunately this "integration" often means that the sloping planes direct most of the sound towards the rear wall. Facing the steps or "coves" toward the audience is usually the better solution, acoustically, but the lighting and ventilation must then be handled in a different way.

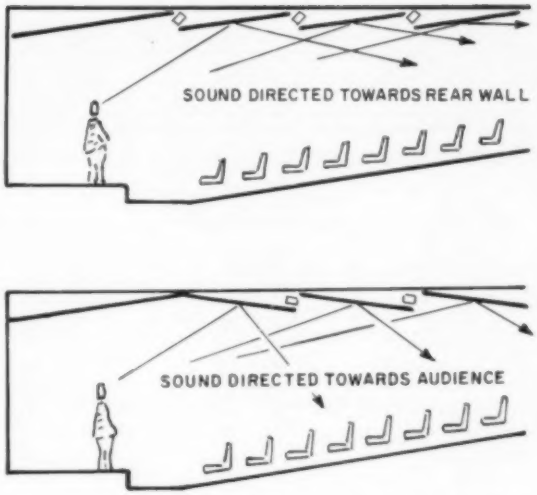


Figure 8. Integrated ceiling design must be shaped to direct sound towards the audience.

A large curved domical shape presents a major problem to the acoustical engineer since the surface tends to focus sound reflections instead of diffusing them. This problem was solved in the Kresge Auditorium at M.I.T. in Cambridge by shielding the domical shape with large sound re-

Figure 9. MIT's Kresge Auditorium sound reflecting panels break up domical ceiling shape, hide ducts and lighting. Glass fiber sound absorbing material is placed on top of panels, as required.

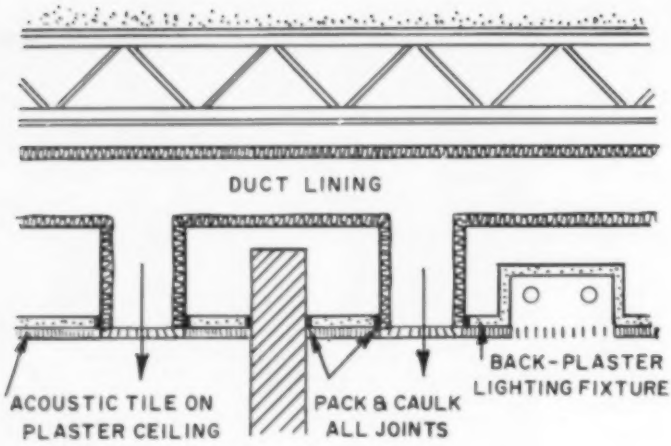


Figure 10. Tight ceiling to compensate for partial-height partitions.

flecting panels suspended from above. This solution not only minimized a potential acoustical problem but it also permitted the integration of the ventilating and lighting systems. Catwalks, ducts, lighting fixtures and lighting bridges for stage lighting were placed above the rows of panels. Finally the upper surfaces of some of these panels were covered with glass fiber blankets to provide the necessary additional sound absorption required in this room for reverberation control. Sound reflecting panels may not always serve such a variety of uses, but they can often be an important part of a ceiling design which integrates the many functions for which a ceiling is so uniquely suited.

Sound Transmission

The third acoustical consideration which concerns the designer of the integrated ceiling is sound transmission. To reduce the transmission of sound from one area to another, we must rely on the attenuation of sound over long distances by physically separating critical areas when laying out the plan of a building, or, more practically, we must separate closely adjacent areas with tight, reasonably heavy construction. The degree to which this is done depends on the use of the space and the level of the sound to be attenuated.

In quiet surroundings, walls and ceilings which will adequately reduce the transmission of sound from adjoining rooms may be unreasonably costly. Thus, a ventilating system which provides a bland ambient background noise which masks intruding sounds is sometimes the preferable, less expensive way of providing a satisfactory acoustical environment. (An unexpected problem sometimes arises with some types of "integrated ceiling" designs which provide ventilation through large low air-velocity openings: they are *too quiet* and create little or no steady background noise. However, acoustical "perfume" designed to mask undesirable intruding sounds has its limits, just as all perfumes do!)

Basically, sound waves "travel" through the air in much the same way that waves travel across the water. Thus, sound waves will pass through openings in a barrier as ocean waves pass through the mouth of a harbor. On the other hand, sound waves impinging on an *impervious* barrier will tend to move this barrier, and the resulting movement of the barrier will generate new sound waves in the air on the other side. When we hear a person speaking on the other side of an impervious masonry wall, the sound waves reaching our ears are actually generated by the movement of the wall which, in turn, is being moved by the sound waves generated by the speaker.

The degree to which sounds are transmitted from one space to another depends on the weight, imperviousness and stiffness of the barrier which separates them. Doubling the weight of a barrier will increase the transmission loss by 6 decibels. A limp barrier will transmit less sound than a stiff barrier of equal weight. A heavy impervious limp barrier such as a floppy lead "curtain" will thus provide the maximum amount of attenuation for each pound per square foot.

Cracks around recessed lighting fixtures and duct openings *totaling* one or two square inches can reduce the transmission loss of a ceiling by 6 decibels! Thus, the sound attenuating value of many ceilings could be markedly increased without any cost by merely designing all of the elements penetrating a ceiling to ensure an air-tight closure. Often, however, the achievement of this aim cannot be the prime consideration.

Obviously, an egg-crate ceiling provides no sound attenuation. In this case, the sound barrier between rooms must be provided by full height parti-

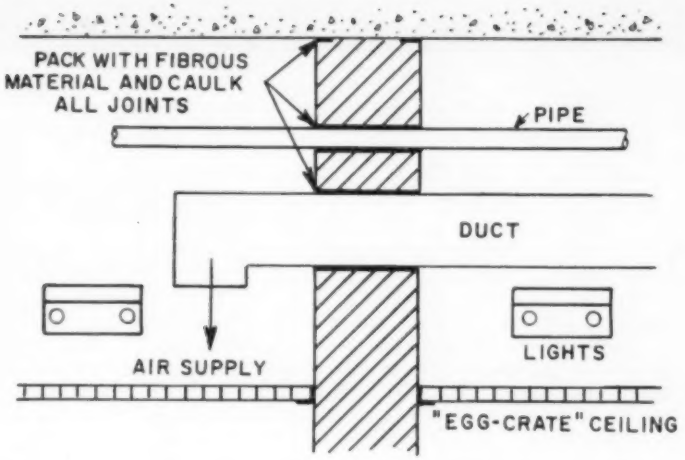


Figure 11. An acoustically "transparent" ceiling needs full height partition to provide sound isolation.

tions. The noise level will dictate the degree of imperviousness and the weight of the partition required. Penetrations from room to room through this above-ceiling closure must be air-tight. Peripheral joints around ducts, conduits and pipes which penetrate this barrier may need to be packed with a fibrous material and caulked.

Many sound absorbing ceiling systems which are fairly dense and heavy or have special impervious backings may provide sufficient attenuation in themselves without requiring that the partition be carried up to the structural slab. (A great deal of research and development in this type of ceiling system has been recently conducted by acoustical materials manufacturers and a great variety of products are available.) The sound in the source room must pass through two layers of acoustic tile *and* the plenum space, on its way to the adjacent room. Therefore, the more loosely an acoustic tile ceiling is fitted, the more holes there are in the recessed lighting fixture enclosures and the larger the gaps around the diffusers, the less efficiently will the ceiling block the transmission of sound. (For this reason, the space above many ceilings is a poor place for installing mechanical equipment such as fans, compressors, large electrical ballasts, etc. Although they may be out of sight they cannot be out of mind!)

Sometimes the problem of "over-the-top" transmission through a poorly fitted light-weight ceiling can be solved by laying a glass fiber blanket, with a paper backing, on top of the acoustic tile ceiling. The paper barrier (on the underside) will cover the small cracks in the ceiling and the exposed glass fiber on top will make the plenum behave like a lined duct, attenuating the sound as it travels through this space to the adjoining room.

In the most critical cases where airborne noise in an adjacent room—or a room above—transmits sound energy vibrations along the structural slab, it may be necessary to suspend a heavy, impervious ceiling on resilient hangers. This minimizes the transmission of structure-borne vibrations into the ceiling hangers and the ceiling. Without this "break" the ceiling would vibrate and excite airborne sound waves in the room below.

Thus, the particular requirements determine the measures to be taken, but an understanding of how sound is transmitted and how it can be attenuated must govern the design and construction of the integrated ceiling to assure a satisfactory acoustical environment, free of undesirable intruding sounds.

Conclusions

We have not analyzed how an integrated ceiling should be designed. Instead, we have attempted to clarify the important acoustical considerations which should be kept in mind by an engineer when he approaches the design of a ceiling system to provide light, heat and ventilation, while providing a satisfactory acoustical environment. Basically, we have tried to show that: (1) Acoustical considerations should influence the designer in *all* aspects of the design of services contained in a ceiling. (2) A ceiling is uniquely suitable for locating provisions for sound control as well as sources of light, ventilation and heating. (3) The behavior of sound energy is not mysterious. Within the limits of our present-day understanding of how sound energy is absorbed, reflected and transmitted, much can be done to provide a comfortable acoustical environment and good hearing conditions. With an understanding of the fundamentals of acoustics, the designer of integrated ceilings should be able to avoid many of the unpleasant acoustical surprises and common pitfalls which plague too many buildings today.

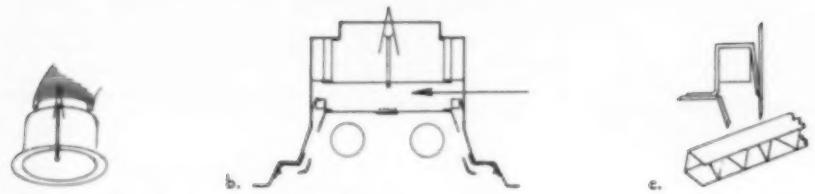


Figure 1. (a) The air valve assembly when installed, completes the physical connection between the combination troffer and flexible tubing. The air flow from duct and flexible tubing into the air distribution chamber may be controlled by adjusting the valve. The opening or closing of the valve is determined by balancing the air flow throughout entire air distribution system. Air valve assemblies are only required on *supply* air troffers, but may be used on return air troffers when necessary. (b) The air distribution chamber is the space between the electrical wireway and light chamber. This space controls flow of conditioned air coming through the valve from the central air conditioning system. It cushions the in-rush of air and equalizes its pressure along troffer's full length so that air discharge direction and rate can be controlled.

(c) The air vanes located parallel to and along outside of air distribution chamber consist of many deflectors and check gates of various sizes, positioned at different angles. The vanes, designed to control direction of air flow as it leaves air chamber, assure even distribution of air pressure on both sides and along troffer's full length.

Figure 1. (d) The air deflector is the extended vertical side of the reflector. It controls air passage and increases its velocity so that its path follows the outside of troffer without direct impingement on lamp. As air passes along outside wall, it gently siphons air from lamp into main stream. This air movement picks up heat from lamp chamber and reduces temperature as much as 20 degrees below that usually found in a "static" troffer, one which does not direct air through light chamber. This resultant bulb wall temperature is very near that calculated to permit *maximum* light output and *true* lamp color.

(e) The air scoop is the curved strip located strategically and carefully just below air deflector. It channels and directs air to the exhaust portals of discharge area. In addition, "baffles" are so placed as to prevent the end spread of two combination troffers in a row from becoming a single "drafty" air column.

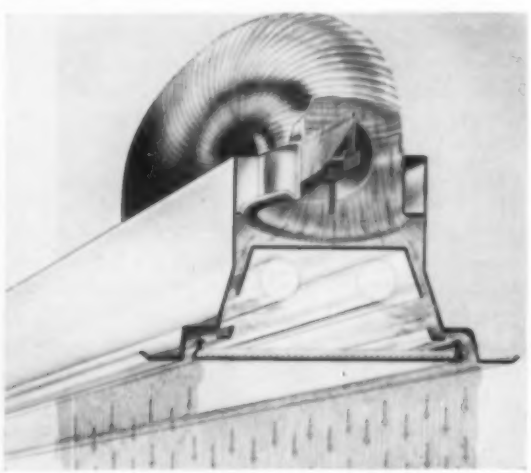


Figure 1. (f) Air turbulators are the dimpled strips forming top and outer surface of discharge portal. They create a mild turbulence in the flow of air slowing its passage into comfort zone. The discharge angle, as the air leaves the combination troffer, is so controlled that the supply air penetrates through the stale contaminated air at the ceiling level. There is little if any "mixing" at this point. The two separate columns of supply air from each side of troffer *coalesce* into one low velocity stream delivering clean air down to the occupied area with positive but comfortable air motion. This continual motion of clean, fresh air into room prevents stagnation, stratification and "short-circuiting;" thereby providing a uniform comfortable atmosphere.

- design concepts
- installation techniques

SINGLE-CASE AIR-HANDLING TROFFERS

By DANA W. ROWTEN
RICHARD E. HARZ

THE COMBINATION of lighting and air distribution into one practical unit is the result of advances that have been made over the years in both the lighting and the air conditioning industries. This "marriage" of the two functions has adapted itself well to the architectural trend toward modular building design, and the increased attention to human environmental conditions.

Early technical investigations into luminaire designs to combine light and air indicated that there is considerable advantage in directing the air through the light chamber and into the room below in a low velocity *coalescent* air stream. It was evident through experimentation that the air flow had to be properly directed through the troffer in the most efficient manner. Early designs literally "dumped" air into the lamp chamber. Coordinated engineered designs have come a long way since then, however, in the development of a practical combination light and air troffer. The "single-case" troffer shown in Fig. 1 (facing page) features air flow through the unit. Air-handling troffers of this nature include numerous interior components such as air valve, air chamber, air vanes, air deflectors, air scoops, air turbulators, etc., designed to achieve optimum air handling characteristics consistent with good lighting quality.

AUTHORS: Sylvania Electric Products Inc., Wheeling, W. Va.

Installation Techniques

During the developmental stages of air-handling troffers, it was theorized that installation problems would hinder the application of this new product. Hundreds of successful installations have belied this, and the "trade difficulties" predicted have also been smoothly worked out. An agreement between the International Brotherhood of Electrical Workers and the Sheet Metal Workers International Association has determined and outlined the proper "worker" to perform the various steps of installation of these equipments. These trade responsibilities are outlined in the accompanying photographs (Figs. 2 through 9) showing the sequence as it relates to single-case combination troffers.

It is important to recognize, however, that a major "contractor" problem is to bring together, for any installation, the proper valve and combination troffer, since many commercially available valves and combination troffers are not interchangeable. Once this fact is clearly understood and handled accordingly, there is little if anything else that remains a problem in the installation of air-handling troffers. Installation of single-case air-handling troffers can start *after* the ceiling contractor has installed the acoustical ceiling, whether it be metal pan (T-bar), kerfed-tile, (concealed spline) or lay-in (exposed) grid.

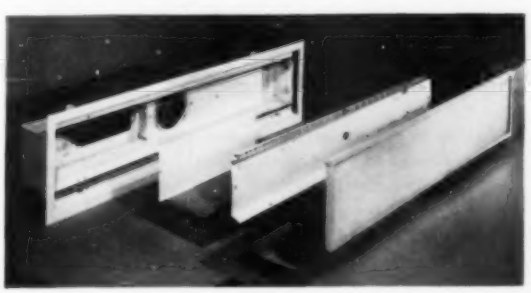
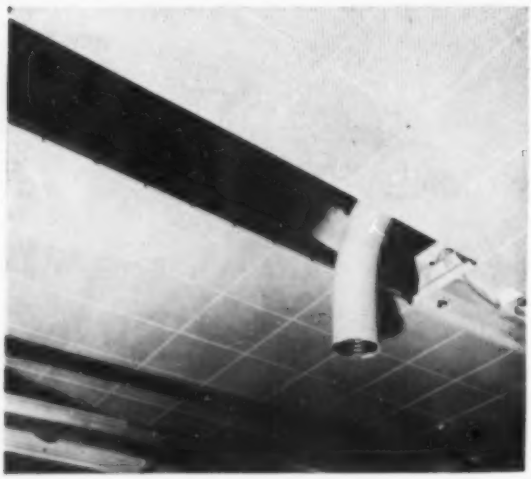


Figure 2. "Exposed" view of typical 2-lamp 1- × 4-inch "single-case" air-handling troffer with plastic lens shielding.



◄ Figure 3. Sheet metal worker connects the flexible tubing to duct collar. He then threads the free end of tubing through the troffer opening in the ceiling, as shown.

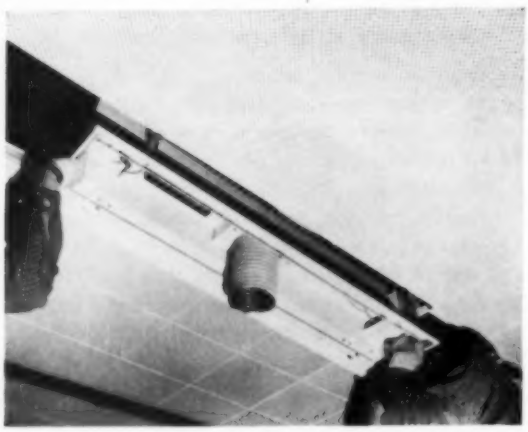


Figure 4. Electrical worker removes center knock- ► out and installs troffer, as shown, after pulling free end of the flexible tubing through the hole.

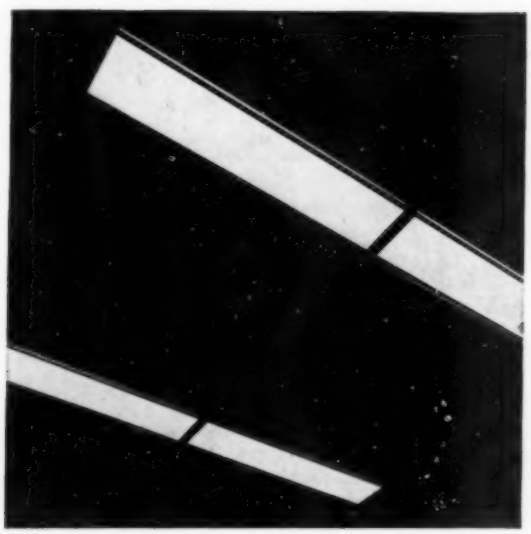
◄ Figure 5. Electrical workers level the troffer as shown, then electrician completes circuit wiring. The wireway cover plate can be installed now or after the air distribution system is balanced.

Figure 6. Sheet metal worker threads air valve ► assembly to the flexible tubing. Note the acoustical ceiling is in place on both sides of combination troffer.

12.122 I.E.S. LIGHTING DATA SHEET

◄ Figure 7. Sheet metal worker then fastens air valve assembly to housing compartment. Note that all work has been done below the ceiling level, which facilitates the installation procedure.

Figure 8. Sheet metal worker balances air system ► with special "Venturi" device available to mechanical contractors installing "single-case" air-handling troffers. While standing on the floor, the worker inserts the long device into the air valve assembly and takes a reading. If adjustment is necessary, the valve is opened or closed depending upon the designed CFM capacity for each unit. This Venturi makes the task of balancing air distribution system much simpler and more accurate, therefore, less time consuming.



◄ Figure 9. Electrical worker installs reflector plate, fluorescent lamps, shield frame with shielding and completes installation as shown.

INSTALLATION AT
ZENKER'S JEWELRY STORE
340 MAIN ST.
ROYERSFORD, PA.

Lighting a Jewelry Store

LIGHTING OBJECTIVE: To provide general and supplementary illumination for the display, appraisal and sale of jewelry, glassware and china.

GENERAL INFORMATION: The sales and display area of this store is approximately 16 feet wide and 35 feet long, including curved portion shown in background of photo; ceiling height is 10 feet. Colors and reflectances of major store surfaces are: ceiling, white (75% RF); walls, light green (63% RF); floor, grey (32% RF); and cabinets, dark walnut (15% RF).

INSTALLATION: Sixteen General Lighting Co. of Philadelphia catalog No. FL-RLP/4-40, one- by four-foot fluorescent troffer units, provide general illumination. Each troffer is equipped with plastic cube louver diffusers and four 40-watt T-12 deluxe cool white rapid-start lamps. These units are recessed in two 32-foot continuous rows on nine-foot centers.

Supplementary illumination for added sparkle on glossy surfaces of the jewelry is provided by seventeen Litecraft catalog No. F341 recessed incandescent downlights, each equipped with one 150-watt R-40 spot lamp. Units are spaced on three-foot centers and are placed to follow the arrangement of the floor display counters. One Litecraft catalog No. G512 recessed adjustable incandescent downlight, equipped with a 150-watt R-40 spot lamp, is located in the rear center of the ceiling to highlight rear display counters.

Average maintained level on counter tops is 150 footcandles. Brightness of major surfaces at that time are: ceiling, 31 fL; walls, 28 fL; floor, 41 fL; wall cabinet trim, 7 fL.

Wall cases are internally lighted by 40-watt T-12 deluxe cool white fluorescent lamps. Supplementary lighting for crystal display (at left in photo) is from 40-watt T-12 deluxe cool white lamps within the soffit, which is enclosed by a plastic cube louver diffuser.

Lighting designed by Charles W. McQuiston, Philadelphia Electric Co., Philadelphia, Pa. Electrical contractor was William Seal, Royersford, Pa.

Lighting data submitted by Charles W. McQuiston and George T. Anderson, Jr., Philadelphia Electric Co., Philadelphia, Pa. as an illustration of good lighting practice and to aid in the design of similar installations.

Published by the Committee on Publications of the Illuminating Engineering Society, 1860 Broadway, New York 23, N. Y. This is one of 24 different sheets in Series XXVI. Subscriptions to the entire series may be purchased from the Publications Office, IES Headquarters, or quantities of individual sheets, minimum 100, may be ordered.

Series XXVI
8-61

A.I.A. File No. 31 f

In Detroit's Newest Office Building . . . .

COORDINATED ENGINEERING ELEMENTS

Reflecting the Detroit of tomorrow, this soaring white structure is symbolic of coordinated engineering elements tied together with sinews of steel. Enclosed in a sculptured white precast quartz aggregate shell—reflecting the sun by day—it vies for attention at night through the glow of its modulated luminous ceiling and sparkling lobby lighting. Crowned with a soaring illuminated tower atop a lacey silhouetted base, it will be a proud part of the new Detroit skyline.

By JOHN J. ANDREWS

MICHIGAN Consolidated Gas Co. Building, located in the heart of the Detroit Civic Center, offered a challenge to the use of the most advanced lighting techniques—a challenge to make the building beautiful both by day and by night—to enhance by lighting, not only the building, but its beautiful environment.

Integrated Design Features

The lighting requirements played an important part in the determination of many of the basic design features of the building. The lighting design thus became an integral part of, and a direct function of many of these design features:

1. *Module:* A 4-foot 8-inch square module was based on the 4-foot fluorescent lighting unit.

2. *Waffle Slab:* The structural waffle slab is based on the 4-foot 8-inch square module. It forms concrete coffers approximately 4 feet square and 25 inches deep. The modular structural waffle is formed within the same depth and plane as the structural steel framing.

3. *Air Electric Floor:* Directly above the structural waffle slab is a combination air electric floor system. This system provides for the circuiting for the lighting and telephone, as well as miscellaneous systems and air distribution to the interior zones.

4. *Lighting Element:* The lighting unit is installed within the cavity of the structural waffle. The waffle legs support the combination partition receiving and wiring channel. The channel supports the hinged diffusing media.

AUTHOR: Electrical Engineer, Minoru Yamasaki—Smith, Hinchman & Grylls, Associated Architects and Engineers, Detroit, Mich.

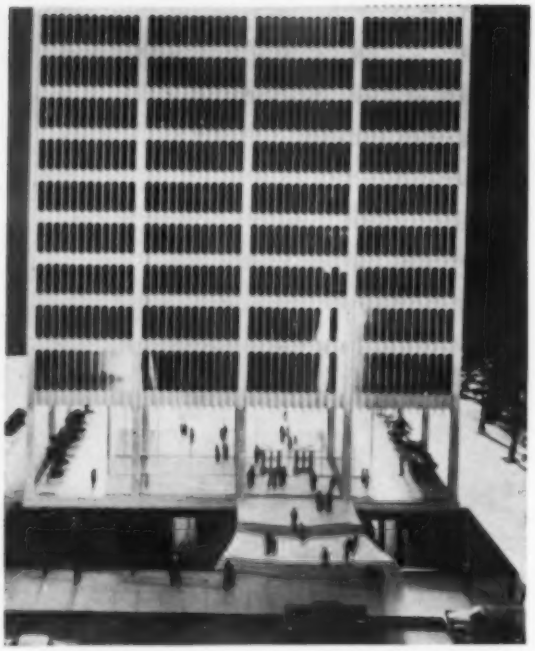


Photo: Baltazar Korab

Close-up of first-floor lobby. Special lighting design for this area uses a multi-faceted, gas-blue, plastic reflecting element to create the effect of a series of gas flames suspended below the ceiling.

Lighting Design Features

The basic lighting design for all typical floors is an over-all luminous ceiling. The lighting element designed to achieve this also performs many other functions which are included with the lighting element design herein outlined:

1. *Lighting Element:* The three-lamp 40-watt fluorescent lighting element is installed within the cavity of the modular concrete waffle.

(a) Luminaire—The lighting unit consists of a baked enamel perforated reflector, approximately four feet square and designed with a removable center section which can be replaced with a two-lamp section, making a four-lamp 40-watt fixture for higher illumination requirements. Ballast and wiring are an integral part of the fixture.

(b) Air Distributor—The reflector is designed to also act as a diffuser and directs the air for interior zones from the air floor above the coffer to the offices below. The reflector is the full width of the coffer in one direction, but provides an open area along two sides for air distribution down through the louver into the office area.

(c) Insulation and Acoustics — The perforated reflector has a one-inch Fiberglas insulation, installed on the top side. This Fiberglas serves to insulate the air plenum above from the heat of the tubes. In conjunction with the perforated reflector, it also serves as an acoustic element, eliminating the need for the application of any acoustic material to the sides and top of the concrete coffer.

2. *Diffusing Media:* The diffusing media consists of a half-inch by half-inch by half-inch eggshell white baked enamel aluminum one-piece louver, installed in a hinged frame and mounted from an adjustable combination partition receiving channel and wireway. The media provides 45-degree shielding with low brightness, giving virtually shadowless lighting. It is finely detailed and engineered to minimum tolerances. Although of sturdy aluminum, it provides a delicate appearing overhead diffusing media, imparting a definite feeling of depth to the ceiling.

3. *Partition Receiving Channel and Wireway:* The combination partition receiving channel and wireway is of satin-finished aluminum. It is installed at the bottom of the coffer legs and occurs on 4-foot 8-inch centers in both directions. It provides a three-quarter-inch-plus vertical adjustment to compensate for floor deflection. As a wireway, it provides for light switching and miscellaneous wiring to the partitions. It is designed to provide a sound barrier, in conjunction with the concrete waffle legs, between offices when soundproof partitions are in place.

Lighting Characteristics

Calculation Factors:

(1) Lamp Lumens: 2520
(2) Utilization factor based on 70 per cent reflectivity of walls and ceiling coffer finish
(3) Maintenance Factor: 70 per cent

Calculated Lighting Levels (Maintained):

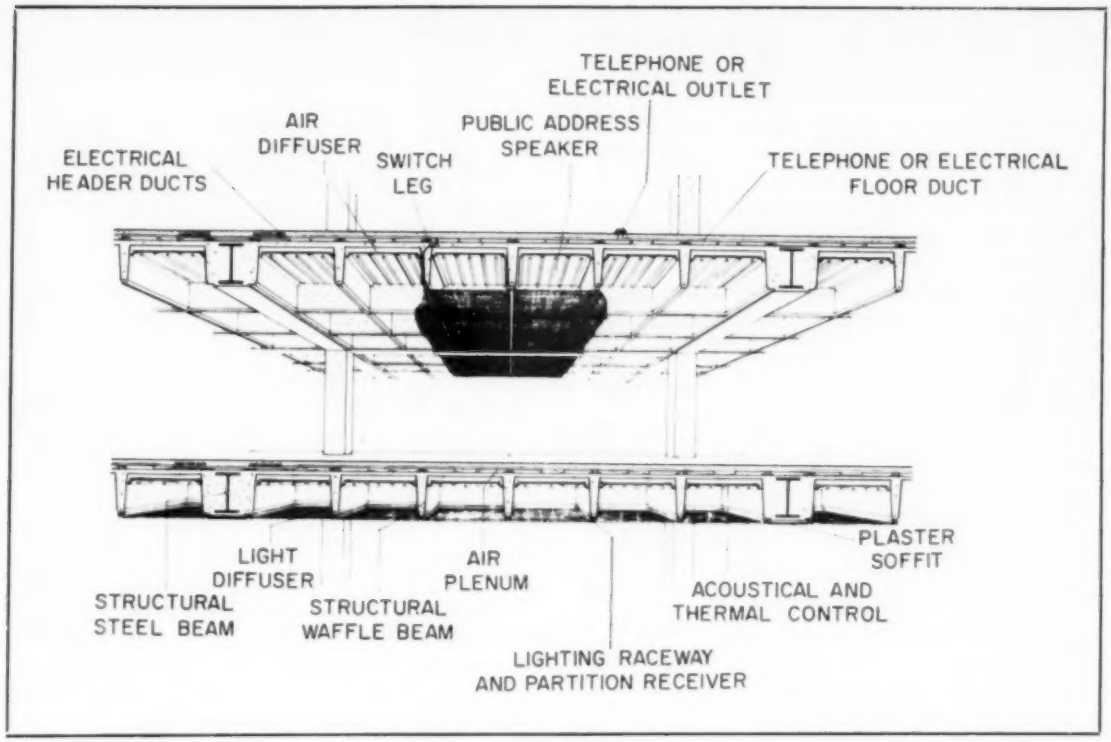
(1) Large Open Offices —	4-tube,	110 fc
	3-tube,	85 fc
(2) Medium Offices —	4-tube,	90 fc
	3-tube,	70 fc
(3) Small Offices —	4-tube,	60 fc
	3-tube,	45 fc

Brightness:

50 footlamberts at 10 degrees above horizontal to a maximum of 80 footlamberts at 30 degrees.

First Floor Special Lighting

The first-floor lobby space is entirely enclosed by a curtain wall. The wall is completely of glass with polished stainless steel mullions, from ceiling to floor. The lobby space is entirely open, except for



Typical integrated floor system.

the elevator and stair shafts. The lighting is provided by a series of specially designed sparkling "jewel lighting" units.

The ceiling consists of a series of plastic 4-foot 8-inch square modular domes. The "sparkling jewel" lighting is achieved by suspending a multi-faceted gas-blue plastic element in the center of the dome. The jewel is supported from the four corners by four delicately sculptured thin polished arms. The sparkling jewel effect is achieved by punching light through a small aperture in the top of the dome. The light is caught by the jewel element below. The greater part of the beams are reflected back into, and light the bottom surface of the dome. Part of the beams are caught by the hundreds of jewels and reflected by their many facets, giving the effect of gas flames suspended below the ceiling. The remaining beams are diverted to the floor below to provide general illumination of the lobby area.

Floodlighting

Two portions of the building are floodlighted, the 27th and 28th floor elevations (lighting gallery) and the 60-foot tower atop the building. On the 27th and 28th floors, walls are set back six feet from the building perimeter wall which is carried up to the 28th floor roof line as a screen of masonry tracery silhouetted against the floodlighted wall. The open sculptured precast walls of the 60-foot tower are set back 36 feet from the main building perimeter. These portions of the building are illuminated with colored lighting capable of being

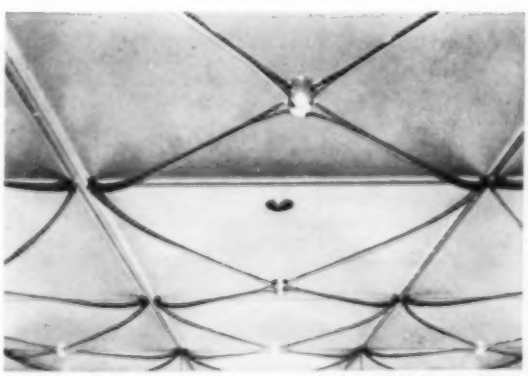


Photo: Baltazar Korab

Close-up of model of lobby ceiling, a series of plastic 4-foot, 8-inch square modular domes. Light is punched through a small aperture in the top of the dome and reflected by a multi-faceted gas-blue plastic element, suspended in the center of the dome by four thin arms.

varied through the entire spectrum for visual effect, as a weather indicator and to provide special color effects for holidays. To accomplish this, banks of red, green and blue floodlights are included at the 27th and 29th floor levels. These lights are connected to dimmer banks which are controlled by an automatic fader system and a preset panel.

The floodlights will be installed in an alternating pattern of red, green and blue, and up to 60 preset scenes will be available for a great variety of lighting effects. Each change of scene will be controlled by the automatic fader system that will smoothly fade one scene out and the next one in.

Lighting Control

Lighting on a typical floor is divided into four control groups: night lighting, general lighting, perimeter lighting and cleaning lighting. In addition, each typical floor is divided into four areas so any area can be turned on or off as required. Night lighting consists of a limited number of lamps controlled directly from breakers in the lighting panels. The other groups are controlled by contactors actuated remotely by impulses from the electronic time and signal system, or locally, by momentary contact push buttons.

Control function is planned as follows:

(1) During normal working hours, all lights will be turned on before the staff arrives.

(2) After the staff leaves at night, the cleaning and general lighting, with the exception of the perimeter lighting, will be turned off unless it is turned back on locally.

(3) When the cleaning group arrives, a third of the lights can be turned on by areas.

(4) Late at night, the perimeter lights will be turned off.

Because of the nature and location of this building, it was felt that at night the surrounding area would be enhanced by having the first two perimeter lighting modules on floors two to twenty-six lighted. The executive floor (25th) lighting required that certain areas be placed on dimmers and also incorporated into the general lighting control scheme. Over-riding contactors were provided in these cases.

Floodlighting dimmer banks are actuated by a photo-electric eye tied into the electronic time and signal system.

Air Electric Floor

The air electric floor incorporates many functions including provisions for power and lighting wiring, telephone wiring, pneumatic tube raceway and miscellaneous distribution systems. The floor was developed jointly by the Architects-Engineers, and engineers of the Granco Steel Products Co.

The air electric floor consists of a series of one-and-one-quarter-inch by four-inch flanged raceways on 2-foot 4-inch centers. These raceways are supported approximately three inches above the structural floor by a series of tubular adjustable screw-jack-type supports.

The raceways, with preset inserts for future installation of electrical and telephone outlets, provide access for wiring to the lighting units below. The cells are fed by a series of header ducts originating at the central electrical distribution shaft. The system is designed to use "access hand holes" in place of the more restrictive standard multiple junction boxes. By depressing the wireways for passage of the header, the finished floor thickness was minimized.

Air Distribution Features

A corrugated metal sheet is installed between and supported on the flanges of the electrical raceways. An air plenum is formed by pouring the lightweight concrete finish floor on top of the insulated corrugated metal deck.

This plenum space is used for the air conditioning system supply and return ductwork. Cool, filtered air from the central air conditioner is supplied through the air plenum to terminal reheat units at the exterior wall window sills, and then into the room. The interior zones are cooled by air which is supplied from ceiling outlets discharging through the lighting fixtures located in the waffle ceiling coffers.

Credits

ARCHITECTURAL DESIGNERS:

Minoru Yamasaki Associates, Inc.

Chief Designer and Firm Sponsor ..... Minoru Yamasaki
Design Coordinators ..... Harold Tsuchiya
Aaron Schreier

ARCHITECTS-ENGINEERS:

Smith, Hinchman & Grylls Associates, Inc.

Firm Sponsor ..... Robert F. Hastings
Administrator ..... F. J. B. Sevald
Project Director ..... John J. Andrews
Architect, Job Captain ..... Richard May
Illuminating Engineer ..... James McDonald
Structural Engineer ..... Peter P. Petkoff
Mechanical Engineer ..... Yoshio Matsumoto
Electrical Engineer ..... John J. Andrews

INTERIOR DESIGNERS: W. B. Ford Associates

CONSULTANT, LOBBY LIGHTING: Lee DuSell

REMODELING FOR

- High Levels
- High Comfort
- Heating
- Air Conditioning

By N. T. KRIDEL
L. C. TWICHELL

Success story of the integration of high-level (200 fc) lighting, heating and cooling in a 35-year-old office building.

When our ten-story main office building (Rochester Gas and Electric Company) was scheduled for expansion and modernization, it seemed to us an excellent opportunity to apply the new IES Recommended Practice for Office Lighting. In fact, we suggested that the installation should *exceed* the new levels, in the hope that the entire building might serve as an example of good lighting for seeing, for perhaps ten years to come.

Our goal to this end was established as a maintained level of 200 footcandles over the entire working area. Discussion with our air conditioning consultant left us with a loading of 10 watts per square foot to accomplish the desired result. We used every watt, to be sure.

Temperature Effect on Lamp Output

Considerable experimentation was undertaken in individual offices with various lighting systems and standard equipment using extra-high-output fluorescent lamps. We noticed, in some of these experiments, a serious falling off of illumination during the first 10 to 20 minutes of burning. It generally took that time for the temperature of the lighting equipment to stabilize with the light falling off from 20 per cent to 30 per cent as the temperature increased. The familiar curve of Fig. 1 shows the effect of temperature on the output of fluorescent lamps. The extra-high-output lamps follow, of course, the same general pattern and per cent variation of earlier and less powerful fluorescent sources. The new difference, and one which some fixture manufacturers seem to overlook, is that this fairly new and powerful source produces over 2½ times as much heat per foot of length as the conventional 40-watt fluorescent lamp. One result of this early experimentation was the indication that good ventilation of these extra-high-output lamps and the control of their ambient temperature was very important for producing an efficient installation.

Ceiling Types

Some thought was given to using a luminous plastic ceiling with the idea of having a separate ventilating system to handle the sensible heat from the lighting equipment. This was discarded early in the preliminary planning stage because of:

(1) the extra equipment needed to shield the

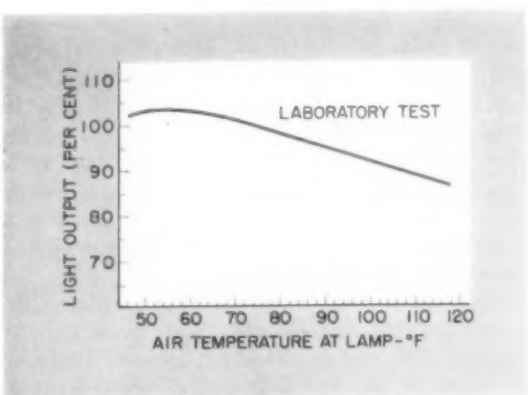


Figure 1. Laboratory test—effect of temperature on light output of extra-high-output fluorescent lamps.

Authors: Illuminating Engineers, Rochester Gas and Electric Co., Rochester, N. Y.

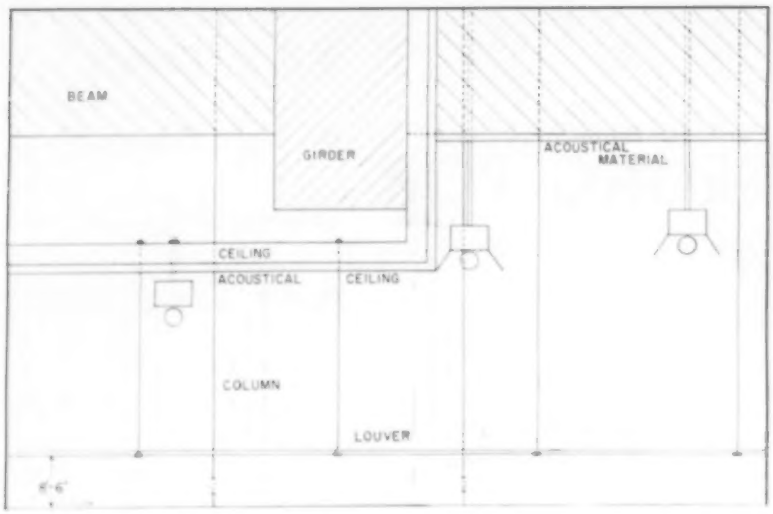


Figure 2. Typical cross section elevation of louverall ceiling installation, Design No. 1.

brightness of the luminous plastic for such large expanses and,

(2) the problem of maintaining a luminous plastic ceiling throughout 10 floors.

Louvered ceilings, we felt, offered a practical means of controlling these two problems. Our air conditioning consultant also favored this type of ceiling. He planned to introduce conditioned air through air diffusers flush with the louvered ceiling and by induction units located around the perimeter of the building under the windows. The exhaust for the most part is taken above the louvers and keeps the lamp ambient at about the same temperature as the occupied area of the room.

Ceiling Patterns

The first three floors to be relighted also had their areas doubled by being extended to the rear. The hung ceiling with 2-foot 6-inch crawl space above, which existed in the original building, was not carried back to these new rear areas. We planned to install a louvered ceiling one foot 10 inches below the existing acoustically treated hung ceiling, leaving a net depth from floor to louvered ceiling of 8 feet 6 inches. This resulted in a five-foot cavity above the louvered ceiling in the new rear areas on these three floors. The omission of the hung ceiling in the new section of the building represented a considerable saving in building cost and caused no problem in the lighting design.

We finally evolved three different lighting designs, one for each of the three floors initially treated. This variety did not stem from indecision on our part, but was by design an opportunity to do some experimenting for our own benefit, that of our customers, and possibly the lighting industry.

Design No. 1

The first floor described (Fig. 2) is a standard louvered ceiling with a single-lamp strip for the extra-high-output lamp mounted independently of the ceiling on 2-foot 6-inch centers. The two-foot by four-foot plastic louver panels are suspended 8 feet 6 inches above the floor by a standard exposed tee-bar system. In the old section of the building the lamp strips were mounted one and a half inches below the existing ceiling with the lamps approximately 18 inches above the louver. In the new section of the building the lamps with reflectors were mounted 29 inches above the louvers. A cross-section diagram of this installation at the dividing beam between the new section of the

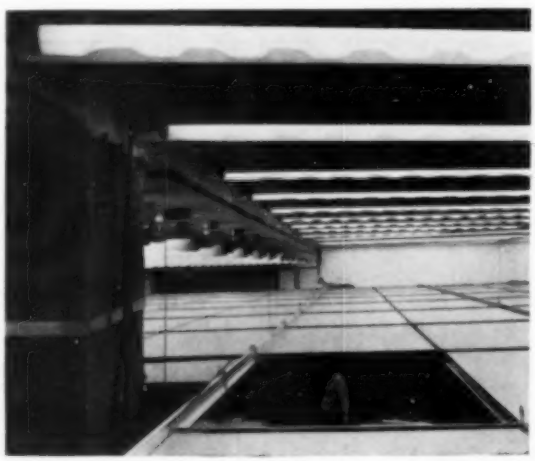


Figure 3. Design No. 1, cavity view between old building and new addition.

Figure 4. Design No. 1, general view.

building and the old is shown. The coefficient of utilization of this installation was estimated at .40 with a Room Ratio of 5.5.

Note that in the photograph (Fig. 3) taken from above the ceiling, the lamps are mounted separately from the louvers and considerably above them, generally conforming to the 1.5-to-1 rule for producing apparent uniform brightness on louvers. Note also that the presence of lamps and channels and supports takes up considerable space which might otherwise be used for air conditioning ducts. As we proceeded in the planning of this project we became more and more conscious of the demands for concealed space from the plumbers and the sheet metal men.

The first design (Fig. 4) gave a fairly pleasing appearance and very comfortable lighting with a level of 220 footcandles after ten months of operation. This was with an ambient temperature of approximately 90 degrees and plenty of construction dust on lamps and louvers. With the air conditioning on and lamp ambient reduced to 75 degrees, we expect to maintain 200 footcandles. The average brightness of the louver is 800 footlamberts at 45 degrees.

Design No. 2

Our second design (Fig. 5) more or less incorported the extra-high-output lamps on twin channels as part of the louvered ceiling. Actually, the lamp channel supports the louvered ceiling with an 18-inch wide section directly below the lamps

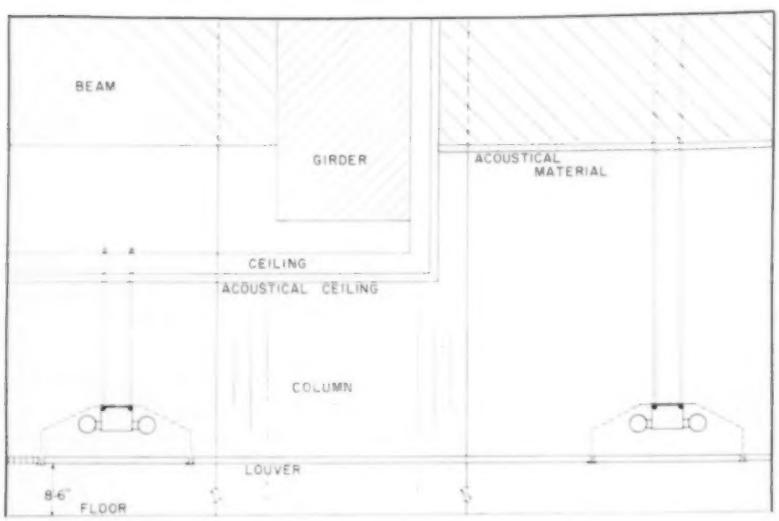


Figure 5. Typical cross section elevation of louverall ceiling lighting installation, Design No. 2.

Figure 6. Design No. 2, general view.

having a brightness of approximately 740 footlamberts. The brightness at the center of the adjoining 4-foot wide panels is 360 footlamberts, an approximate 2-to-1 ratio. The trick here is to space the lamps just high enough above the louvers (8 inches) so as to light uniformly the 18-inch wide louvered section with no appreciable spilling over into the 4-foot section which, of course, is largely lighted by the indirect light from the acoustical material and white painted ducts above. Note the appearance (Fig. 6) of the 18-inch strips of light separated by 4 feet of lower-brightness plastic louvers. Actually, the 18-inch wide strip of louver has a slightly denser coloring in the plastic to reduce the brightness to a value more in line with the less dense 4-foot section. We had planned to use a different type of plastic louver on Designs No. 1 and No. 2 but ran into trouble with the local Sprinkler Code Authorities on flame spread ratings, so we employed the same louver for both Designs No. 1 and No. 2. The footcandles at the desk top after eight months' operation averaged 215. The coefficient of this system was estimated at .50 for a Room Ratio of 3.0.

Design No. 3

For our third and final design (Fig. 7) we worked out another ceiling pattern. This is similar

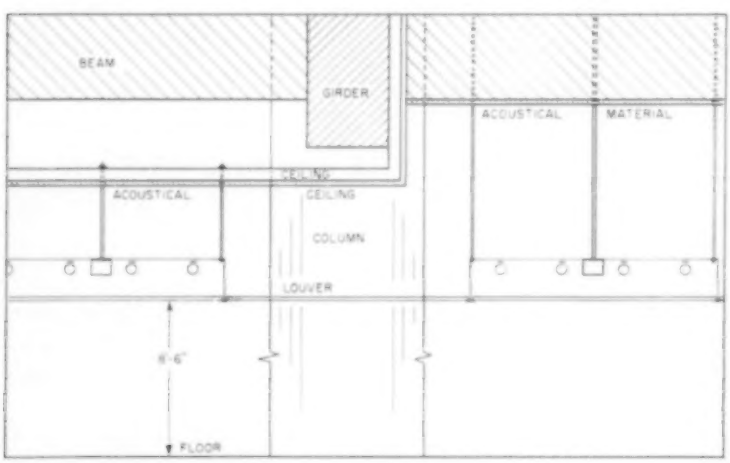


Figure 7. Typical cross section elevation of louverall ceiling lighting installation, Design No. 3.

Figure 8. Design No. 3, general view with temporary occupants.

in principle to Design No. 2 but aims at a saving on installation labor by using a 4-foot by 8-foot four-lamp extra-high-output fixture. These units are on 6-foot by 12-foot centers, each island of light surrounded by a 4-foot width of indirectly lighted louvers. On this floor the louvers are ¾-inch by ¾-inch by ¾-inch, white painted aluminum. Brightnesses are 830 footlamberts and 200 footlamberts, an approximate 4 to 1 ratio. Footeandles averaged 205 after three months' operation. The estimated coefficient of utilization for this system was .45 for a Room Ratio of 4.0.

The temporary telephone and other dangling wires shown in Fig. 8 indicate the checker game that goes on with various divisions, including Lighting, during such a program of modernization in a 35-year-old building. As rapidly as the trades can work, the remainder of the ten-story building is getting similar treatment.

Importance of Lamp Ventilation

We would like to stress particularly the importance of maintaining low ambient operating temperatures in equipment in which the extra-high-output lamps operate. To confirm our concern with this, we made a series of tests on the actual installation prior to the operation of the air conditioning system in the building. As shown in Fig. 9 we measured an approximate drop in footeandles of 30 per cent as the ambient temperature increased 30°F. An apparent peak lumen output is reached at an ambient air temperature of 60°F, which corresponded in our tests to a bulb wall temperature of 85°F. This checks roughly with the laboratory test curve shown in Fig. 1.

At the time this article was prepared, air conditioning had not been available in the relighted offices. During this current summer, however, we expect to compile further data on this effect with the air conditioning system in operation.

Conclusion

With the materials and light sources now available, it is relatively easy to design comfortable, high level, efficient office lighting installations for existing buildings as well as new structures.

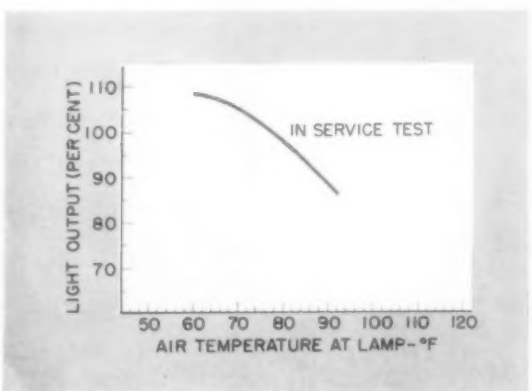


Figure 9. In service test—effect of temperature on light output of extra-high-output fluorescent lamps.

- **Lighting — 100-250 fc**
- **Heating — with lighting**
- **Coordinated Air Conditioning for**

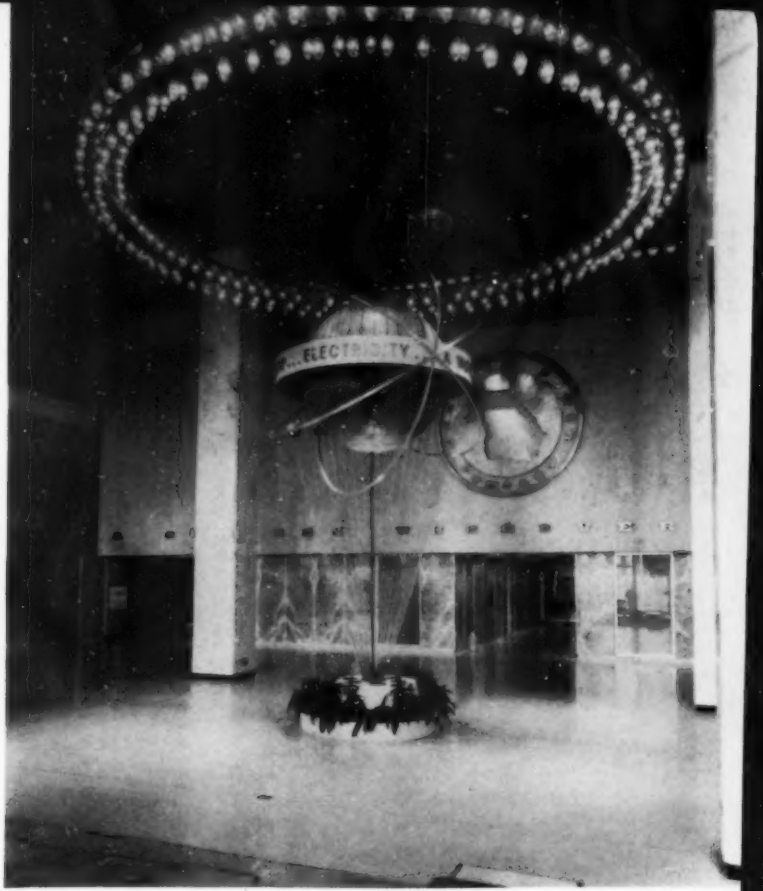
NEW CONSTRUCTION

For new construction, a pace-setter in the concept of "heating with light" is the new 22-story office building of the Georgia Power Co. in Atlanta. Several trades and professions will watch with interest for further news of this building. It is one of the first, if not the only new building which has been planned expressly to meet the IES recommended practice for office lighting.

Not the least of its interesting aspects is the coordination of heating and cooling with its lighting. The lighting system, for the most part 100 to 250 footcandles, takes over, completely, the heating of the entire building.

A detailed description of this coordinated system appeared in the article "Heating with Light" by J. B. Browder, June 1960 IE, page 360. On the following three pages are a few glimpses of the now completed and occupied office spaces.

Main lobby. Lighting in this area is by Abe Feder. Spectacular chandelier is color-phased and automatically controlled.



Side units in elevator lobby use 1500-ma lamps and gold honeycomb shielding.

Typical floor lobby—with four-lamp four-foot troffers, with 45- by 45-degree shielding.

◀ One of the large office areas. Four-lamp four-foot troffers on six-foot centers provide 150 fc; light surfaces maintain recommended brightness ratio.

▲ Elevator foyers have 100 fc and good air distribution, from suspended ceiling of honeycomb louvers.

▼ Typical small office—150 footcandles.

▲ Executive office. Single-lamp strips above a dished acrylic plastic ceiling. Dividing strips are perforated aluminum, gold anodized and dipped in acrylic resin.

Snack bar has lower levels of lighting and colorful suspended baffles for pleasing atmosphere. ▶

Views and Opinions

The Need for Caution

It is now just three years since the first presentation in IE of Dr. Blackwell's work in the field of illumination levels, and two years since Dr. Blackwell's own paper appeared in the publication. In the same June 1959 issue which included that paper, a special message from IES President George Taylor emphasized that:

> "Dr. Blackwell's research team itself is not responsible for the establishment of any of the illumination levels; that all of the published footcandle values, new or old, are established by IES technical committee groups of lighting experts after consideration of all valid illumination research findings, known lighting principles, and vast field experience."

It seems that this caution needs repeating at the present time. The Society owes much to Dr. Blackwell for the many thousands of measurements made in his laboratory, which have greatly augmented our knowledge, and for his logical breakdown of the process of seeing in terms of field factors (FF) and visual assimilations per second (APS).

It must, however, be remembered that although these FF and APS factors exert an enormous leverage on the precise data obtained in the laboratory measurements, the values assigned to them are, as yet, only assumed. Such factors are a necessary element in determining desirable practice, and we know they must be of substantial order; but quantitatively they are still in the realm of speculation and judgment. As Dr. Blackwell pointed out on page 348 of his 1959 paper: "There is no adequate factual basis for assigning levels of visual capacity and field factors to actual practical tasks at this time."

Despite this warning and other statements regarding the limitations, one finds a rather prevalent impression—and not infrequent representation—that at last illumination requirements have been established with scientific precision. The statement in the 1959 Annual Report of the Trustees of the Illuminating Engineering Research Institute: "Now we have achieved a system for accurately determining lighting needs for individual seeing tasks," has, it appears, contributed to the misapprehension by being construed as implying an "accuracy" unwarranted for the illumination values set forth in the 1958 Report No. 1 of the RQQ committee.

As has been stated, the effect of variations in FF and APS are startling. Take the case of reading poor Thermofax copies, Task 13 in Dr. Blackwell's paper. His first calculation suggested 589 footcandles, and this was based on a field factor of 15. In his 1959 paper, he expressed the opinion that the proper factor for such a task is 10 instead of 15. This reduction of one-third in the field factor taken alone brings the required illumination from 589 footcandles to 28.2.

In reading, the eye fixates four or five times per second, and both the 589 footcandles and the 28.2 footcandles were premised on the idea that the eye would assimilate information at the rate of five items per second —5 APS. In his 1959 paper, Dr. Blackwell takes the position that in reading the Thermofax copy one should assimilate 30 items per second—30 APS—instead of 5, and this change boosts the necessary footcandles from 28.2 to more than 5020, an increase of nearly 200 to 1. The IES technical committee very wisely decided not to accept any one of these figures, but recommended 150 footcandles for this task, based upon their well-informed judgment, pending the establishment of a more factual basis for field factors and assimilations per second.

Again, in Dr. Blackwell's work it is assumed that operators and inspectors have normal vision but are naive. For example, 3470 footcandles are indicated for task 52, inspecting rolled edge effects on white handkerchiefs. If these inspectors were as skilled in their own line as Blackwell's laboratory assistants are in theirs, the illumination requirement would be reduced to less than 20 footcandles, according to his data. If they fell half-way between the novice and the expert, they would presumably need about 100 footcandles, and, although this particular task is not included in the IES tables, I believe that about 100 footcandles is what the practicing engineer would choose for this task.

As you study the IES tables, you will find that with the exception of some hospital surgical requirements, they do not deal in thousands of footcandles, and that, in general, they have been found by practical experience to be reasonable and in the best interest of the user. They do not suggest a precise scientific basis, but rather, as President Taylor stated, a combination of research findings, known lighting principles, and vast field experience. There are no recommendations calling for 28.2 footcandles.

It is imperative that the lighting profession keep clearly in mind the actual status of our knowledge, and particularly that those involved in the work of the IES and who may have occasion to speak as its representatives shall at all times avoid unwarranted implications as to the basis for its recommendations. To fail to do so might seriously jeopardize the standing of the Society as a responsible technical organization. It would indeed be deplorable if, through improper representations in its use, confidence were impaired in the growing and exceedingly valuable body of knowledge being developed through the research of Dr. Blackwell and other highly competent scientists. WARD HARRISON, *Cleveland, Ohio.*

Successful offspring of the "marriage" of lighting, heating, cooling, acoustics and other services (to thoroughly mix up a metaphor) are springing up all over the country. Their influence on future trends in all these fields is expected to be considerable. A few of the hundreds of installations which have developed from the basic concept of integrating lighting and other environmental services are shown on these pages.

APPLICATIONS

Photo: Rochester Gas and Electric Co.

One of the foremost remodeling installations featuring the integration of lighting, heating and air conditioning is that underway at the Rochester Gas and Electric Co. building. Note in this view that private offices are located along exterior walls. The problem of balancing heat from lamps with supplementary peripheral system steam heat differs from comfort balance for interior space. Complex engineering questions have been resolved with control equipment providing accommodation of temperature choice for various areas. Luminous ceiling lighting delivers more than 200 footcandles maintained in service.

New integrated ceiling system at National Life Insurance Co. Montpelier, Vt., covers 3½ acres of office space. The system combines illumination, acoustical control, air conditioning, fire protection and space conditioning. The design (see drawing) is based o a four-foot module which permits partitioning of offices to desired sizes. More than 9000 four-foot square units, each with six removable baffles, and two 48-inch slimline fluorescent lamps, comprise the system. Lamps are operated at 200 ma to provide about 75 fc in general offices. Ballasts are easily accessible, and could be replaced quickly for 430-ma operation should more light be planned for particular areas. Accessibility and ease of maintenance were considered from early design stages. Lamps can be removed and replaced without removing baffles. Acoustical reflector panels can be lifted and moved aside for easy access to plenum without disturbing these elements either. Better than 45-degree shielding provides visual comfort from the huge expanse of ceiling. System was designed by Willard Thompson.

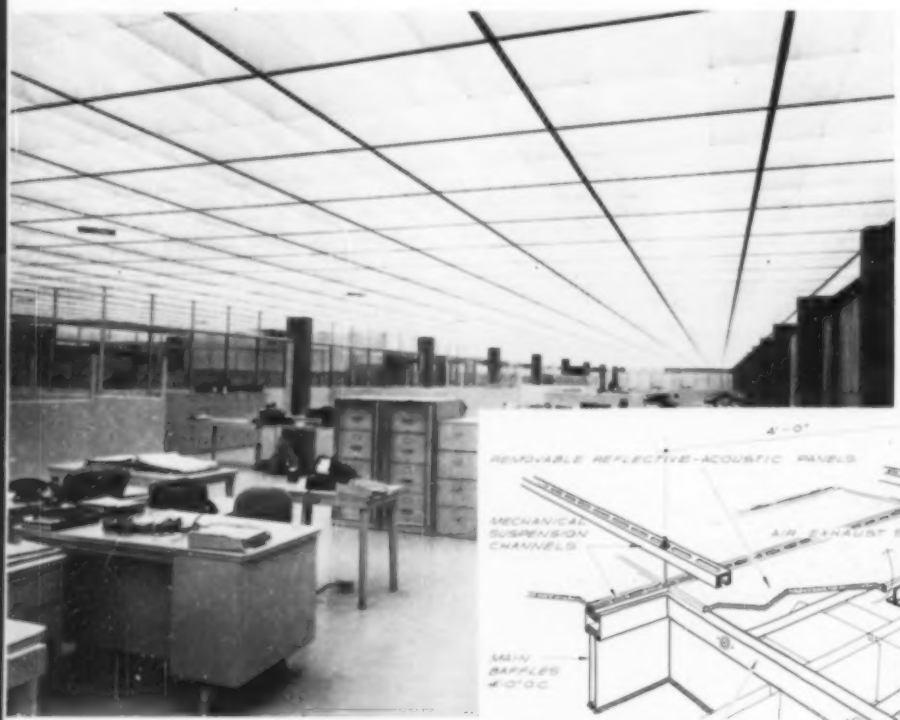
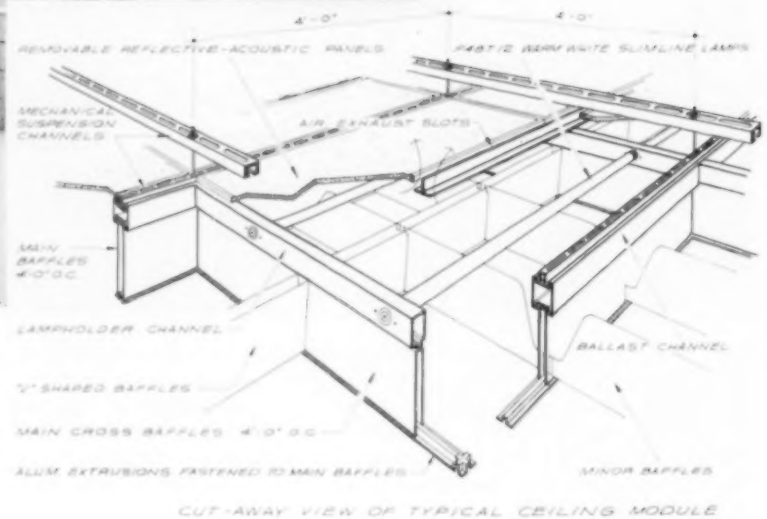


Photo: Luminous Ceilings Inc., Chicago, Ill.
Drawing: Light *Magazine, General Electric Co.*



CUT-AWAY VIEW OF TYPICAL CEILING MODULE

ALC entry by R. C. Putnam and E. G. Zacharias, Case Institute of Technology, Cleveland Section.

Today's answers to old problems are exemplified in the new library at Case Institute of Technology, Cleveland. Even with the low (eight-foot) ceiling, uniform high-level lighting with no excessive brightness has been provided on the vertical surfaces of the bookshelves and horizontal surfaces of the card catalogs and desks. Although all low-brightness luminaires look identical, some of them introduce conditioned air into the space, at low velocity, through a center baffle.

Photo: Day-Brite Lighting, Inc., St. Louis, Mo.

In this private office the ceiling of fixtures prevented the use of separate air diffusers. Instead, luminaires themselves are diffusers, supplying air to the room through unobtrusive slots along the sides of the enclosure. The lighting level is 500 fc. Walls, ceiling and floor coverings are, of course, light in color and non-glossy to avoid sharp contrast and "hot spots."

Photo: Day-Brite Lighting Inc., St. Louis, Mo.

Fresh approach to supermarket lighting is this installation in Indianapolis. The neat arrangement of troffers combines high level, diffuse illumination and air handling services. Conventional air diffusers previously installed caused a loss of cold air in the open-top frozen food bins, due to a scooping effect of the high-velocity air streams. The air handling troffers, with multiple apertures and a resultant lower volume of air per aperture, have eliminated this effect entirely.

Photo: Sylvania Electric Products Inc., Wheeling, W. Va.

Another interesting remodeled installation is the 26-story Riverside Plaza office building (formerly the Chicago Daily News Building) in downtown Chicago. Supply air handling troffers installed in the interior of the building have been balanced to provide 72 CFM, while the perimeter units are adjusted to provide 80 CFM. Return air-handling troffers were installed to eliminate stale, hot, "used" air at the ceiling level. At the same time, return air units carry off a high percentage of the heat energy created by the fluorescent lamps (40-watt standard cool white) and ballasts and prevent the heat from reaching the occupied area. Illumination level is 70 footcandles.

The new Pure Oil Co. building, located four miles south of Palestine, Ill., gives the impression of having been designed entirely for employee comfort. In the general office shown, careful planning went into every feature of the visual environment. The troffers are designed for both supply and return air handling functions. Illumination levels range upward from 100 footcandles.

Photo: Day-Brite Lighting Inc., St. Louis, Mo.

ALC entry by Stephen H. Wiesler, Meckler Engineering Co., Toledo, Ohio, Northwestern Ohio Section.

At the R & J Furniture Co. store in Canton, Ohio, lighting system is completely integrated, physically and functionally, with the building's structural, architectural and mechanical systems. Heat pumps, which are basically air conditioners that reverse cycle to produce heat, remove excess heat from areas requiring cooling and transfer it to areas calling for heat. No heat is required in interior zone even at −10°F outside temperature. Space cooling of interior areas, which is necessary at all times, is achieved by mixing return air with cold outside air in the necessary proportions. This air then displaces an equal volume of warm space air into the return air plenum.

Although a visitor to the Oklahoma Gas and Electric Co. reception room (above) would probably not realize it, this room is lighted to a level of 300 footcandles from a 12- by 16-foot luminous area composed by recessed air-handling luminaires shielded with glass lens plates. The renovated offices of the company (below) set an example of good office lighting to the community, with levels which meet or exceed IES recommended practice and comfortable brightness ratios. Two-foot wide troffers provide both lighting and conditioned air distribution. Both photos courtesy of Day-Brite Lighting, Inc., St. Louis, Mo.

Photo: Benjamin Division, Thomas Industries Inc., Des Plaines, Ill.

Banks and offices have been in the vanguard in the use of combination lighting and cooling as an answer to structural problems. Atlanta's First National Bank (above) achieves an unobtrusive, orderly ceiling with the use of 40-watt rapid-start troffers which supply 75 footcandles of illumination as well as air conditioning to the area.

Most of the heating load in this printing plant, L.S.T. typography Co., Chicago, (right) is provided by the lighting system. Heat pumps provide air conditioning and additional heating in the all-electric plant. Lighting levels of 200 footcandles are provided by 1500-ma lamps in low brightness luminaires having 35-degree shielding and a 42 per cent upward component. The units are mounted on eight-foot centers at a height of 11 feet.

Photo: General Electric Co., Cleveland, Ohio.

Engineer checks temperature rise of experimental floodlight as part of prototype development.

12½-foot-high photometric sphere is one of the useful tools in Revere's research and development laboratory.

What makes Revere the consultant's outdoor lighting choice?

Revere creative engineering makes sure you get all of the light you specify

Consulting electrical engineers know that their clients get all of the light they pay for from Revere equipment. That's because Revere policy is to design up to a performance level, never down to a price level.

From product design right through application engineering, Revere people refuse to compromise with quality in construction and performance. A Revere luminaire not only puts out the total light specified, it puts it out with maximum utilization and efficiency.

The next time you're ready to specify outdoor lighting equipment, be a little skeptical, a little demanding. Ask yourself whether you've really been getting the engineered performance you've specified. Then choose the best way to do your job from the widest line of quality fluorescent, incandescent, and mercury luminaires, poles, fittings and accessories on the market. You'll find that Revere equipment is *design* matched for peak lighting efficiency and *structurally* matched for strength, balance and trouble-free installation.

Write for the comprehensive Revere catalog. Ask any Revere sales engineer to answer your questions about how our complete lighting line can serve your interest. Remember, if you don't see what you need, Revere can design it for you — and get it out to your job on time.

Revere ELECTRIC MFG. CO.

OUTDOOR LIGHTING

Revere Electric Mfg. Co. • 7420 Lehigh Avenue • Chicago 48, Illinois (In suburban Niles)
Long Distance Phone: NIles 7-6060 • Chicago Phone: SPring 4-1200 • Telegrams: WUX Niles

Research worker selects a calibrated lamp to aid in development of a new outdoor lighting unit.

Revere application engineers fit design-matched equipment to a variety of routine and unusual jobs.

Unique "shower bath" tests weather resistance of newly-designed luminaire under extreme conditions.

LIGHTING NEWS

Dr. Deane B. Judd—1961 IES Gold Medalist

Dr. Deane B. Judd, the outstanding authority on color in the United States today, has been unanimously approved by the IES Council as the 1961 recipient of the IES Gold Medal. The Medal and accompanying citation will be presented to Dr. Judd by IES President, Richard G. Slauer, at the Opening Session of the National Technical Conference in St. Louis on September 25.

In addition to honoring Dr. Judd's personal scientific achievements in relation to the goals of IES, his selection as medalist is symbolic of the importance of the role of color in illuminating engineering. Although Dr. Judd, himself, is not a member of IES, his major contributions to scientific knowledge in the broad areas of the standard observer for colorimetry and photometry, light scattering properties of materials, color blindness, indices of whiteness, uniform color scales, color names, color differences and color tolerances, chromatic adaptation, and color reproduction on television, have contributed significantly to the science of illumination. His pioneering work in the development and establishment of the internationally used method for the measurement of color, incorporating the standard observer for photometry, is of fundamental importance to illuminating engineering. Currently, he is engaged in the development of a system for the measurement of light and color which will be applicable for 10-degree (large field) viewing, supplementing the current system which is particularly applicable for 3-degree (small field) viewing.

Dr. Judd's work in color, photometry and vision has been documented in over 100 research papers and reports published in scientific journals in the United States and abroad. His book, *Color in Business, Science and Industry*, published in 1951, is among the most widely-used in the field.

As United States representative to the International Commission on Illumination's (CIE) committee on colorimetry since 1931, Dr. Judd has won international esteem. Evidence of his eminence

Deane B. Judd

in his field is his position as chairman of the CIE International Committee of Experts on Colorimetry, an office he has held since the inception of that committee in 1955. From 1948 to 1955, Dr. Judd served as chairman of the CIE Technical Secretariat on Colorimetry, predecessor of the present committee. In connection with the work of that committee he personally prepared and presented the committee's report to the CIE sessions in Paris in 1948; Stockholm, 1951; Zurich, 1955, and Brussels, 1959. He has also served with distinction as a member of the CIE committees on color rendition and colors of signal lights.

Further in the international sphere, Dr. Judd has been the United States representative for colorimetry to the International Commission on Optics since 1948, served as a delegate to the 1947 Conference on Color Vision in Cambridge, England; the International Discussion of Problems of Color Metrics, in Heidelberg, 1955; and a Symposium on Visual Problems of Colour, Teddington, England, 1957. Since 1949 he has been a guest lecturer at the Instituto de Optica in Madrid, Spain, earning the title of visiting professor in 1957. His conduct in each of these international activities has marked him as a first-rate diplomat, scientist and patriot.

Dr. Judd's committee activities have, by no means, been confined to international work. He has served as chairman of the Committee on Uniform Color Scales of the Optical Society of America; member of the IES Subcommittee on Color Rendition of Light Sources (since 1952); member of the National Academy of Sciences' NRC Committee on Vision; and member of the American Society for Testing Materials' Committee on Appearance.

Dr. Judd is unique in the history of the Inter-Society Color Council, having been the only ISCC Chairman ever to have served for two terms, from 1940 to 1944. He was also president of the Optical Society of America from 1953 to 1955, is currently editor of that Society's journal, and has been president of the Munsell Color Foundation since 1942.

Dr. Judd received his B.A. and M.A. from Ohio State University and his Ph.D., in physics, from Cornell University in 1926. After a year (1926-1927) as a research associate in colorimetry at the Munsell Color Foundation, he joined the National Bureau of Standards, U. S. Department of Commerce, Washington, D. C., where, since 1946, he has been in charge of the colorimetry group. In 1950 he was honored by the Department of Commerce with an Exceptional Service Award.

In selecting Dr. Judd as the recipient of the 1961 Gold Medal, IES joins the Society of Motion Picture Engineers, the Inter-Society Color Council and the Optical Society of America in tribute to a notable scientific career. Dr. Judd has previously been honored with the SMPTE's Journal Award (1936), the ISCC's first Godlove Award (1957) and the OSA's Frederick Ives Medal (1958). Dr. Judd joins a distinguished list of IES Gold Medalists: George H. Stickney, Preston S. Millar, E. C. Crittenden, Matthew Luckiesh, Sir Clifford Paterson, Ward Harrison, W. F. Little, H. H. Magdsick, E. F. Lowry, J. L. Stair, George S. Crampton, John O. Kraehenbuehl, C. A. B. Halvorson, N. A. Halbertsma and Willard C. Brown.

MONOTUBE POLES
in steel or aluminum

. . . engineering and styling to meet today's rigid outdoor lighting requirements

Business District Lighting

Highway Lighting

Area Lighting

Residential Lighting

UNION METAL

THE UNION METAL MANUFACTURING COMPANY

Canton 5, Ohio Brampton, Ontario

Monotube Engineered Lighting Poles

1961 Regional Conferences—A Review

All nine Regional Conferences are viewed in this report as one major IES project. In the over-all Society view, the activity is just that—a plan to bring, to each area, an identical opportunity for local members to participate in a practical two day convention.

Although all conferences are patterned to the same Guide, each manages to impart its own "flavor" within this format. Some transcend this, to present meetings of extraordinary stature. Two in this class in 1961 would certainly be the Research Symposium which comprised the South Pacific Coast Regional Conference, and the School Lighting Seminar at the University of Oklahoma (Southwestern Regional Conference).

Even without such major themes as these, however, the Society's aim of bringing practical lighting information and helpful discussion, to local members, by way of the Conferences, seems to be carried out. Note the nature of the subjects presented this year, culled from the programs of all of the Conferences. If the attendance at individual Conferences is only a fraction of the Region's membership, it would appear that this is not the fault of the programs presented.

Most of the subjects presented at this year's conferences reflect what's hot in lighting this year—which is as it should be. Some of these: The integration of lighting and air conditioning; the scissors curve, and how to use it; higher levels—how to get them; higher levels—comfort considerations of; coordinating with the architects, to cite just samples.

South Pacific Coast IERI Symposium

There is, obviously, very high interest in lighting research. South Pacific Coast devoted its entire Conference to the theme, "Research—to Technology—to Application in Visual Engineering." Essentially the program was a Symposium of the Illuminating Engineering Research Institute, with leading research personalities presenting interim reports. This program attracted an attendance of 561 people. This is almost 30 per cent of the total attendance for all nine conferences. Significant as these *numbers* may be, of still greater interest is the *identity* of

(*Text continued on page* 20A)

IES President Richard G. Slauer, a featured speaker at every Regional Conference. Here he is at Montreal.

Notable Conference Subjects

• Research. Both days of the South Pacific Coast Conference in Sacramento were devoted to interim reports on current IERI research projects. Lighting research was also discussed at the Inter-Mountain Conference in Salt Lake City (by C. L. Crouch and Dr. H. R. Blackwell), at the Great Lakes Conference in Cincinnati (by Dr. Blackwell), and at the Pacific Northwest Conference in Harrison Springs, British Columbia (by Willard Allphin of Sylvania).

• School lighting and current teaching methods. A seminar on this subject featured top educators and school administrators, at a full-day program in Oklahoma City. School lighting was also a popular subject at the conferences in Montreal and Harrison Springs, both by John Chorlton, and a panel discussion on the subject was presented at the Pacific Northwest meeting in Harrison Springs, B. C.

• Integration of lighting, heating and air conditioning—currently a top subject in lighting. A panel of experts discussed it in Philadelphia; Murray Quin (Day-Brite) spoke on it at Asbury Park; Walter Haspedis (Columbia Lighting) at Salt Lake City; and J. E. Sweatte (Georgia Power) at the joint Southern Regional Conference in Atlanta.

• Discussion of the scissors curve was ably handled and well received at three of the conferences. Eric Church (Lighting Products) presented this at Oklahoma City; J. E. Sweatte in Atlanta; and Don McCormack (J. A. Wilson Lighting) in Montreal.

• Predictions for the sixties was a subject tantalizing enough to be featured at seven of the nine conferences. Speakers on various aspects of this: Berlon C. Cooper, of McGraw-Hill; Robert C. Dorsey, General Electric; John D. Harrison, of J. A. Wilson Lighting; H. A. Williams, of Rohm and Haas; and Bruce A. Beverly, Westinghouse.

• "Five Faults of Modern Lighting Design" was an excellent and helpful talk by Gene G. Rae (Holophane). He joined the circuit to present this in Atlanta, Salt Lake City and Harrison Springs, B. C.

• Architects, speaking for their side, or engineers urging coordination, were popular speakers. This general subject was a feature of three programs: Northeastern; Southwestern and Inter-Mountain.

• Street lighting engineers present at the conferences had plenty to interest them. The topic was presented at five of the programs.

• New light sources is a must every year. Ted Sargent, Bob Wylie and Leo Duval covered it for Sylvania; Bob Dorsey for General Electric (three meetings) and D. E. Picini for Westinghouse. It was a feature at seven conferences.

• Other subjects of notable attention included: New developments in ballasts, maintenance, quality and atmosphere, solid state dimmers, floodlighting, and new techniques for industrial lighting.

Personalities at Sacramento meeting. Photo at left, R. G. Slauer, Henry Wright, Rod Doerr, A. L. Wakefield. In photo at right: Dr. H. Richard Blackwell, left, and C. L. Crouch.

IERI Symposium—South Pacific Coast, Sacramento

Foster K. Sampson (left) and Professor Everett M. Strong after a session.

Karl Freund (left) demonstrates instrument to Fred Berteloni (center) and Grant Radford.

Dr. Glenn Fry and Willard Allphin.

Charles Macy left; John Chorlton.

These are the men who put on the show (l. to r.): Roy Kreyser, Regional V-P; Charles Gibson, Program Chairman; R. G. Slauer, IES President; Mel Fenton, Conference Chairman; and Eldon Harris, Chairman of Mother Lode Section, host to Sacramento meeting.

SPEAKERS

(above) Jan Reynolds, Sylvania, at the Canadian Regional Conference.

(left) C. M. Deasy, FAIA, was the keynote speaker at the luncheon session of South Pacific Coast Conference.

IERI Symposium at Sacramento. Left, Charles D. Gibson, California Division of School Planning; right, Dr. Harry Helson, Texas University.

School Lighting Seminar speakers at the University of Oklahoma. L to r., R. T. Dorsey, T. C. Sargent, Dr. O. D. Johns, Wilbur Riddle, Mendel Glickman, R. D. Bradley.

R. T. Dorsey, General Electric, Nela Park, spoke at almost all of the Regional Conferences.

A. F. Wakefield, Chairman of the Board of Trustees, Illuminating Engineering Research Institute, presented organizational data on the Research Institute at the Inter-Mountain Conference, Salt Lake City.

SOCIAL ACTIVITIES

(right) Wonderful ladies' programs were part of every conference. This group with the East Central Regional Conference in Philadelphia is leaving for a bus trip and luncheon party.

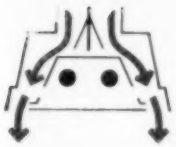
Civic reception in Montreal City Hall. Entire conference was guest of the city for a buffet supper. Shown here, President R. G. Slauer signing the guest book; and Adrian Angers, Pro-Mayor of Montreal.

Receiving line for the formal party in President Slauer's honor at the Southwestern Regional Conference in Oklahoma City. L. to r., R. Turpin, incoming Regional V-P; Mrs. Turpin; President and Mrs. Slauer; John Deck, Regional V-P; J. Dale Hampton, Chairman of the host Chapter, Central Oklahoma.

(above) After business, pleasure—and IESers have as great a talent for one as the other. Gemutlichtkeit in Cincinnati.

(left) A real, genuine, serious Fashion Show had been planned as part of the entertainment for the Northeastern Conference at Asbury Park, N. J. When the professional models failed to appear, male members of the New Jersey Section rounded up "fashion items" on short notice, and ad-libbed a show. Results were hilarious. The "model" here is Cy Burck.

THE MULTI-VENT SYSTEM OF LIGHTING AND AIR DIFFUSION



20% MORE LIGHTING EFFICIENCY

Through exclusive patented design the Multi-Vent system, the only true combination, directs the air through the troffer, bypassing the lamps, thereby creating a controlled lamp cooling effect. Heat is drawn out and away from the lamps assuring operation at close to optimum temperature. The result is guaranteed greater lighting efficiency with uniform color control. Write for Multi-Vent technical data.

THE MULTI-VENT SYSTEM GIVES YOU

More light output
Longer ballast life
True lamp color—all lamp types
Reduced maintenance
Superior room air-conditioning—no stagnation
Trade union approved installation procedure
Ease of installation—actual lowest cost
Quick, low cost air distribution balancing
Flexibility of wall placement—no rebalancing
No ceiling or wall smudging—lowest maintenance
Quietest air diffusion—no drafts
Lowest total cost—ask for our comparison data

THIS SYSTEM IS AVAILABLE FROM THE FOLLOWING MANUFACTURERS:

COLUMBIA
Columbia Lighting
Spokane, Washington

MILLER
The Miller Co.
Meriden, Connecticut

PYLE-NATIONAL
The Pyle-National Company
1334 N. Kostner Avenue
Chicago 51, Illinois

SYLVANIA
Sylvania Electric Products, Inc.
Wheeling, West Virginia

AWARDS AND PRIZES

Wilbur Riddle, left, presents Elmer Prag Scholarship to this year's winner, Gail Hodgson. Scholarship is presented each year by the Central Oklahoma Chapter of IES, to outstanding architectural student at the University of Oklahoma. *Photo: Gordon Dinsmore.*

Lasting reminders of their visits to the Regions were presented to President and Mrs. Slauer at each Conference. The scene above is at the Canadian Regional Conference, Montreal, with incoming RVP Jean Paul Cristel, center.

Attendance Trophy, Southern Conference, Atlanta, presented by Past-President J. B. Browder, left, to J. A. Stelly, New Orleans Section. In foreground, Mrs. R. G. Slauer.

Triumphant winners of the Applied Lighting Competition received checks and certificates from President Slauer. Above is Inter-Mountain winner, Harold Stead (left), of the Arizona Section.

Past RVP, Beverly A. Travis, left, receives Certificate of Appreciation from President Slauer. Plaque was awarded during ceremonies at the Pacific Northwest Regional Conference, Harrison Springs, B. C.

Northeastern Regional Applied Lighting Competition contestants above are left to right: Carl Cramer, Connecticut; Kenneth Huck, New Jersey; Carl R. Johnson, New Jersey (Class II winner); J. I. Hargis, ALC Chairman; President Slauer; R. R. Northrup, Housatonic, (Class I winner); Henry J. Wald, New York; and Francis Clark, Connecticut.

WORKERS

(left) This is the talented committee for the South Pacific Coast Regional Conference; similar groups worked many months before and during the nine conferences. Chairman was Mel Fenton, far left.

Session chairmen for some of the technical sessions at the joint Southeastern and South Central Conference: Regional V-P Cecil L. Cannon, Robert P. Fulmer, Charles R. Minors, Regional V-P John S. Williams, and George Gill.

Out-of-Region judges serve at all of the Applied Lighting Competitions. This group, in Oklahoma City: R. T. Dorsey, Ray Imre, Rose Coakley, Ruby Redford, and T. C. Sargent. *Photo: Gordon Dinsmore.*

Regional Veeps—these, for Inter-Mountain, incumbent Lloyd S. Reed, left, and incoming Vice-President, Robert Godemann.

At all the Conferences, Section and Chapter officers served as session chairmen. The group shown happens to be: William Benndorf, Arizona Section; J. E. Watson, Rocky Mountain Section; J. E. Parker, Southern Colorado Chapter; W. A. Huckins, Jr., Utah Section; and A. W. Boehning, New Mexico Chapter.

Introducing...

THESE MODERN FACILITIES ARE AT YOUR DISPOSAL

ENGINEERING

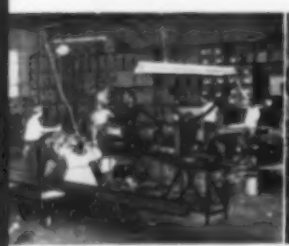
DECOILING — PRIMARY SHEAR

SHEARING

PRESS BRAKE

METAL FINISHING

PAINT SPRAY OPERATION



POLE FORMING

POLE WELDING

DRILLING

DOOR ASSEMBLY

FINAL ASSEMBLY

PACKING

PORTION OF MAIN WAREHOUSE

GENERAL OFFICE

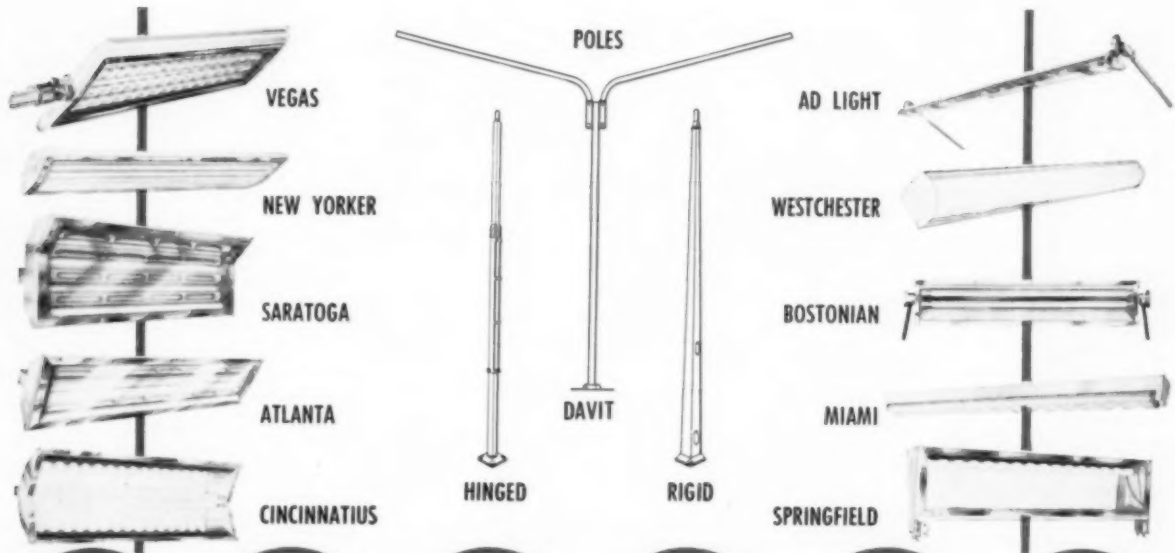
ADVERTISING

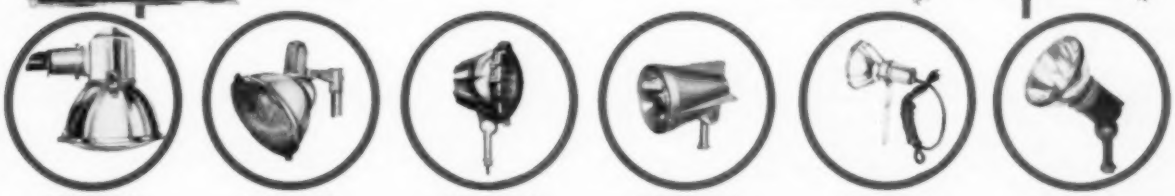
PRINTING

PHOTO ENGRAVING

THE J. H. Spaulding COMPANY

SPECIFY THE BEST IN OUTDOOR LIGHTING . . . SPAULDING





LEXINGTON Mercury Vapor Floodlight

HARTFORD Incandescent Floodlight

405 Model Incandescent Lampholder

403 Model Incandescent Lampholder

STAKE-LITE Incandescent Lampholder

401 Model Incandescent Lampholder

THE J. H. SPAULDING COMPANY PROUDLY OFFERS IN ITS NEW COMPREHENSIVE LINE OF OUTDOOR LIGHTING EQUIPMENT NEW SOLUTIONS TO YOUR LIGHTING PROBLEMS. WHERE TOP QUALITY AND GUARANTEED PERFORMANCE ARE A NECESSITY, YOU CAN SPECIFY SPAULDING WITH CONFIDENCE.

A COPY OF OUR NEW GENERAL CATALOG IS YOURS FOR THE ASKING

DESIGNERS OF AMERICA'S MOST DISTINCTIVE OUTDOOR LIGHTING

THE J. H. Spaulding COMPANY • 3731 DIRR STREET • CINCINNATI 23, OHIO
Phone Klrby 1-3486

1961 IES Regional Conferences

Region	Place	Date	Attendance	Chairman
East Central	Philadelphia, Pa.	April 10-11	130	Ralph R. Enghouser
Southwestern	Oklahoma City, Okla.	April 17-18	136	Paul R. Sheline
Southeastern and South Central	Atlanta, Ga.	April 20-21	212	Charles R. Minors
Inter-Mountain	Salt Lake City, Utah	May 1-2	145	Wayne Mulcock and Donald Dyrenforth
South Pacific Coast	Sacramento, Calif.	May 4-5	561	M. P. Fenton
Pacific Northwest	Harrison Springs, B.C.	May 8-9	214	E. A. Adams
Canadian	Montreal, Que.	May 15-16	261	J. P. Cristel
Northeastern	Asbury Park, N. J.	June 8-9	130	Bruce J. Jensen
Great Lakes	Cincinnati, Ohio	June 19-20	150	H. K. Flint
		TOTAL	1939	

(*Continued from page* 11A)

the delegates. IES membership attendance within the Region was high, of course, but in addition a third of the registration was drawn from non-members and allied professions and industries. Further, an additional 75 school administrators and students attended free, on invitation of the Conference Committee.

The moral is clear: What IES is doing, and what is underway in IERI, as told by the men closest to it, is knowledge eagerly sought. South Pacific Coast did a great service in disseminating this knowledge. They have had very gratifying indications that their efforts have been successful in establishing considerable rapport between IES and its "public."

The roster of speakers at the Symposium is impressive. From all corners of the country came:

A. L. Wakefield, Vermilion, Ohio, Chairman, Board of Trustees, IERI.

Henry L. Wright, FAIA, First Vice-President of AIA, and a member of the IERI Board of Trustees.

Dr. H. Richard Blackwell, Director, Institute for Research in Vision, Ohio State University, who is conducting notable IERI researches.

C. L. Crouch, Technical Director of IES, and Secretary of the Research Institute.

Professor E. M. Strong, Cornell University, Ithaca, N. Y., Chairman, Executive Committee of IERI.

Dr. Glenn Fry, Director, School of Optometry, Ohio State University, Columbus, Ohio, another researcher and a member of the IERI Technical Advisory Committee on Light and Vision.

Willard Allphin, Research Engineer with Sylvania Electric Products Inc., a member of the Technical Advisory Committee on Light and Vision.

Karl Freund, Photo Research Corp., Hollywood, Calif., who is associated with instrumentation for research.

John Chorlton, Toronto Board of Education, Toronto, Ont., conducting researches for IERI.

Dr. Harry Helson, University of Texas, Austin, Texas, conducting color research for IERI.

A handsome brochure was developed for the Conference, outlining the structure of the Research Institute, listing its projects and their results, and covering the speakers included in the Symposium.

Southwestern Conference—School Lighting Seminar

For the first day of its two-day meeting, Southwestern Region moved its entire conference, via chartered buses, to the University of Oklahoma at Norman, Okla. There they participated in a School Lighting Seminar of very high caliber.

The seminar, designed to study the influence of teaching methods, architectural design, economics, and visual environments on school lighting design, presented a rare opportunity, indeed, for lighting engineers and the large group of University of Oklahoma architectural students who also joined the meeting. Again, such a program did much to "spread the gospel" to a significant group outside of IES. At the same time it provided Society members with an opportunity, they might otherwise not have, for obtaining information on a subject influencing their profession.

Some of the subjects covered were:

(*Continued on page* 24A)

TEN-MINUTE radio interview of President Richard G. Slauer (left) by WCKY (Cincinnati) reporter Lloyd Baldwin provided excellent public relations for IES during the Great Lakes Regional Conference.

Each of these Kopp glass parts was engineered to do a specific job

REPRESENTATIVE KOPP PRODUCTS

(Reading from top, left to right)

TRAFFIC signal lens for pedestrian control
Traffic signal lens for street and highway control
Traffic lens for multiple-lane control

MARINE floating light lens
Marine color filter
Marine stern light lens

RAILROAD lantern globe
Railroad switchlamp lens
Railroad fresnel globe

SURGICAL heat absorbing lamp filter

LIGHTING refractor for street lighting
Lighting lens—flat fresnel for interior lighting
Lighting museums and art galleries—color-correcting glass
Lighting lens—beam control

FLOODLIGHTING cover glass

INDUSTRIAL vapor-proof globe
Industrial control board indicator lens
Industrial sight glass

SWIMMING POOL color-correcting lens

THEATRICAL lighting color filter
Theatrical and TV spotlight lens

AIRCRAFT wingtip lens
Airport runway lens
Aircraft wingtip part
Airport runway color filter
Airport runway bi-color lens

AUTOMOTIVE turn signal arrow
Automotive dome

DENTAL light color-correcting filter

Perhaps we can help you with your problem . . .

Whether you need a lens, color filter, cover glass, or some other special part, Kopp can engineer and custom-produce a product to meet that need. It will be designed to provide the right light and color transmission and distribution, heat-resistance, mechanical strength—in fact, the exact combination of properties needed to do your special job. Write us about your needs.

KOPP GLASS, Inc. • SWISSVALE, PENNSYLVANIA

KOPP GLASS, INC. IE
SWISSVALE, PA.

☐ Please send FREE copy of "This is Kopp Glass."

☐ Enclosing preliminary drawing and application information for your suggestions.

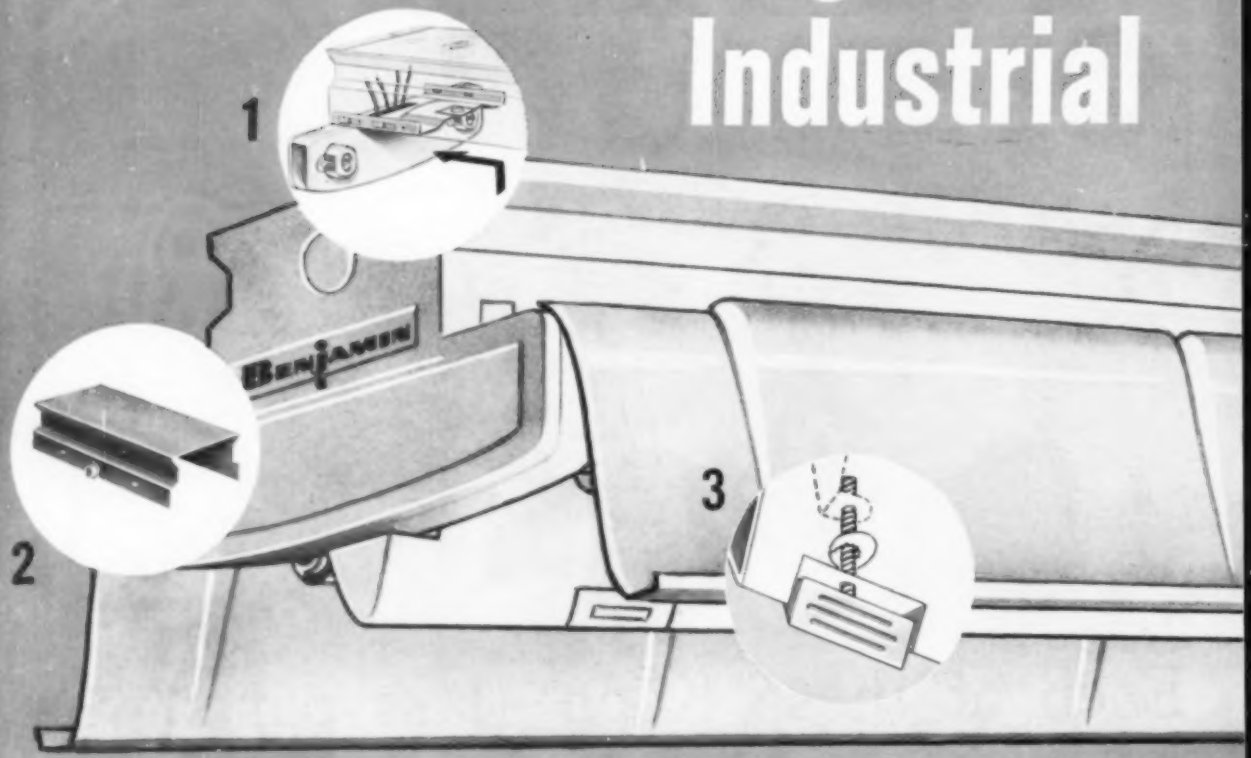
NAME_____

COMPANY_____ TITLE_____

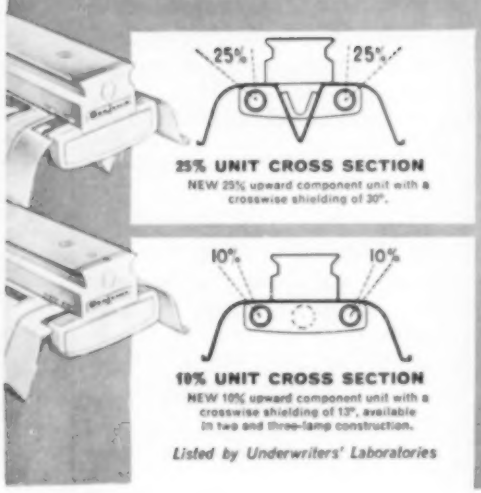
ADDRESS_____

CITY_____ STATE_____

Now! Benjamin Industrial



NEVER BEFORE SO MANY OUTSTANDING



25% UNIT CROSS SECTION
NEW 25% upward component unit with a crosswise shielding of 30°.

10% UNIT CROSS SECTION
NEW 10% upward component unit with a crosswise shielding of 13°, available in two and three-lamp construction.

Listed by Underwriters' Laboratories

Yes, here is industrial lighting that lifts light levels to new highs. The answer to demands for more and better lighting from each fixture, without added cost. ***Now, Benjamin has custom-engineered an entire line to meet the varied requirements of modern industry.*** Only Benjamin could bring you RLM quality at such a truly economical price.

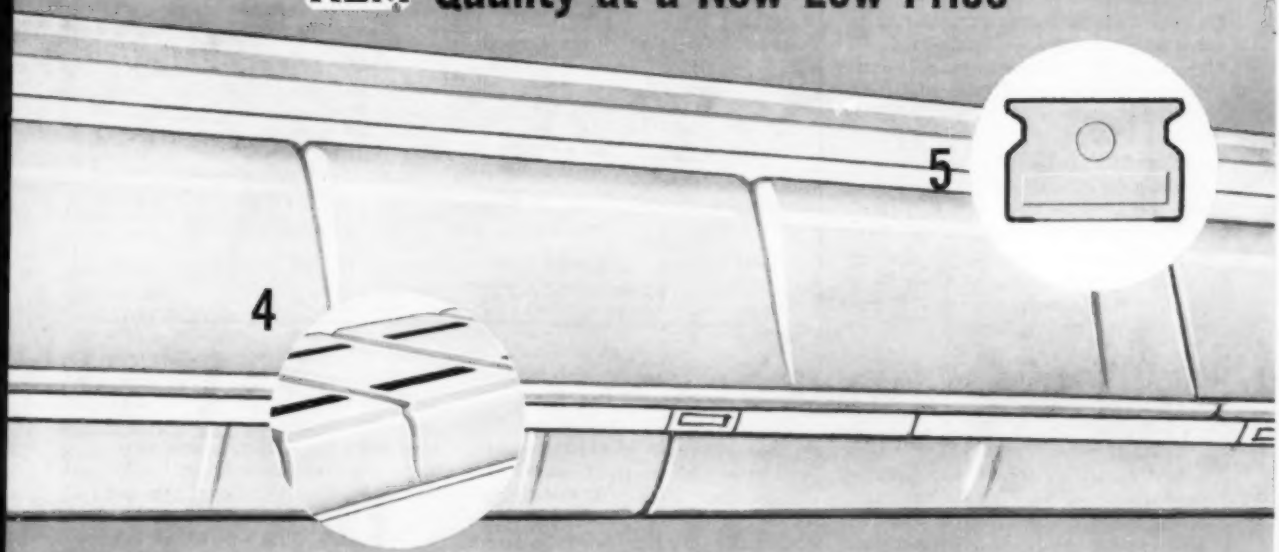
Examine the complete Benjamin lines of • **POWER GROOVE** • **SHO-VHO** units • **SLIMLINE** • **40-WATT** and **800 ma. RAPID-START UNITS.** See how Benjamin gives you *extra value* for your lighting dollar. Call your Benjamin representative today to plan the correct custom-engineered fixtures for your use.

NEW PROTECTED FLUORESCENT UNITS *available with completely corrosion-resistant monel metal lampholders, porcelain frames, stainless steel spring clips, in addition to the famous Benjamin one-piece housing.*

BREAKS THE LIGHT BARRIER IN

Fluorescent Lighting

RLM Quality at a New Low Price



FEATURES

1 *New* SNAPLOX LAMPHOLDER
Snaps into wiring channel and locks in position, assuring rigid, trouble-free mounting.

2 *New* CONCEALED COUPLER
Slides inside wiring channel, allowing units to butt snugly together for easier continuous row installation.

3 *New* TWIST-LOCK THUMB LATCH
Simplified thumb latch offers new ease in reflector installation.

4 *New* DOUBLE EMBOSSED REFLECTORS
Extra rigidity is added by vertical embossed ribs and horizontal ridges. Gives extra strength and assures rattle free installation.

5 *New* EXTRA STRENGTH WIRING CHANNEL
Reinforced ribs insure rigidity, serve as a holding element for all Benjamin sliding hanger suspensions.

Write for Bulletin F — new 20-page technical and specification bulletin on Benjamin Industrial Fluorescent lighting. Address Benjamin Division, Thomas Industries Inc., 207 E. Broadway, Louisville 2, Ky., Dept. BC -6

BENJAMIN DIVISION
THOMAS INDUSTRIES INC.
The World's Largest Single Source of Lighting for Industry, Commerce and Home.

Send FREE copy of 20-page Bulletin F on Industrial Fluorescent Lighting to:

COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____
NAME_____

(Continued from page 20A)

teaching machines, ungraded schools, extended school day, year-round school year, extended week, evening classes, master teachers, audio-visual education, movable partitions, classrooms from 10 to 300 pupils, more fluid space, geodisic domes. It was apparent to the group that new school buildings and new lighting will need to anticipate these new methods of education to avoid early obsolescence. In his talk summarizing the information gleaned from the Seminar, speaker Wilbur Riddle emphasized that educational techniques will need to be studied by the architect and engineer, so that he may provide the proper environment for these new methods of education.

School administrators participating in the Seminar included: Professor J. D. Palmer, Electrical Engineering Department; Mendel Glickman, Chairman, School of Architecture; and Dr. O. D. Johns, Professor of Education, all of the University of Oklahoma. Lighting specialists, speaking for school lighting design were: Wilbur Riddle, architect, and R. T. Dorsey, both of General Electric Co., Nela Park, Cleveland, Ohio; R. D. Bradley, Day-Brite Lighting Inc., St. Louis, Mo.; and T. C. Sargent, Sylvania Electric Products Inc., Salem, Mass.

ALC Regional Winners — 1961

Region	Class I (Residential)	Class II (Commercial)
Canadian	Gwen Butterworth Toronto Section	Gerard Denis St. Maurice Valley Chapter
East Central	Elizabeth A. Meehan Philadelphia Section	Albert A. Fox Capital Section
Great Lakes	Hazel Harbaur Northwestern Ohio Section	Fred L. Lantz Michigan Section
Inter-Mountain	William B. Keller Arizona Section	Harold Stead Arizona Section
Midwestern North Central	(No Conference. Contest to be held in September.)	
Northeastern	John Northrup, Jr. Housatonic Chapter	Carl Johnson New Jersey Section
Pacific Northwest	Grace Schoeni Oregon Section	Gene Ibson Oregon Section
South Central	May Love Gale Tennessee Valley Section	Mario G. Zervigon New Orleans Section
Southeastern	Glenn Yopp Tar Heel Section	John Ponzer Tar Heel Section
South Pacific Coast	Peter R. Darnton San Jose Chapter	Hunter Lauer Golden Gate Section
Southwestern	Glenna Kobel Central Oklahoma Chapter	J. Dowell Weeks San Jacinto Section

Applied Lighting Competitions

All nine Regional Conferences held a competition for both Residential (Class I) and Commercial (Class II) ALC entries. Competing, of course, were Section/Chapter winners from previously held local competitions. Winners received prizes of $100, and will participate in a travel prize to present their entries at the national competition in St. Louis next month. Names of these national contestants are shown in the accompanying box.

Quite a few of the "good ideas" from previous conferences were put into practice at many of the meetings this year. IES President Richard G. Slauer was a featured speaker at special luncheon sessions at all of the conferences. In several cases, other groups were invited to hear this address. Most conferences also scheduled a special luncheon meeting for Sustaining Members.

Conference committees of hard-working men and women at every conference deserve the Society's sincerest thanks for excellent jobs of planning, organization and performance. IES Regional Conferences have a professionalism about them that could only be achieved through the efforts of these dedicated people.

ABOUT PEOPLE

Parenthetical designations denote membership grade in the Society.

The James R. Kearney Corp., St. Louis, Mo., and Hubbard and Co., Chicago, Ill., jointly announced the election of **Charles P. Wenner** as chairman of the board of directors of both companies. Mr. Wenner, formerly president of Kearney and a director of Hubbard, replaces **Franklin H. Kissner** who has resigned as chairman but will continue to serve as a director of both companies. Elected as president of Kearney was **John R. Morrill.** In addition to his new position, Mr. Morrill will continue as Hubbard president.

Max D. Orr (M) has been elected executive vice-president of Advance Transformer Co., Chicago, Ill. Formerly president-director of marketing, he is also past chairman of Certified Ballast Manufacturers, and a member of IES's Finance Committee. Also announced was the appointment of **William Weber, Jr.,** as director of manufacturing. He replaces **Robert B. Negele,** who was made executive vice-president of Chicago Magnet Wire Co., a subsidiary of Consolidated Electronics Industries.

R. K. Turner was elected a vice-president of Union Carbide Corp. and **William B. Humes,** president of Union Carbide Plastics Co., according to a recent announcement by **Birny Mason, Jr.,** president of Union Carbide Corp., New York. Mr. Turner has served as Plastics Co. president since 1947; Mr. Humes has been vice-president of the company since 1959. Union Carbide Plastics also announced three other assignments. **Richard L. Garrison** has been appointed assistant regional manager in the North Central sales region. He will be located in the Detroit district sales office at Detroit, Mich. **W. Kenneth Hill** will be a technical sales representative for plastics in the New England sales region and **Harry J. McGowan** will be a special sales representative in North Central sales.

The election of **Bernard W. Brooks** as president and member of the board of Sheffield Plastics, Inc., Sheffield, Mass.,

(Continued on page 27A)

How You Can Eliminate Fluorescent Ballast Noise Problems in Your Buildings

Today's trend toward higher levels of illumination—increasing the number of fixtures, lamps, and ballasts, or increasing the wattage of the lamp/ballast systems—makes fluorescent ballast sound a more and more important building consideration.

General Electric wants you to take full advantage of modern lighting levels. At the same time, you should assure yourself that you can solve any audible ballast "hum" problems in your lighting installation with minimum attention and effort.

ALL YOU HAVE TO DO IS . . .

1. Check each lighting installation *while it is still on the drawing board* with the General Electric Sound Rating Calculator* (see below) to predetermine whether ballast noise will be a problem, and . . .
2. Specify the appropriate *General Electric* sound-rated ballasts for the installation.

That's it. By properly following this two-step procedure, you can predict and overcome potential ballast noise problems before they exist.

General Electric, with five years of highly successful experience in the G-E Ballast Sound-control Program, is confident that this procedure will solve your ballast noise problems. Here's how the program works . . .

THE GENERAL ELECTRIC BALLAST SOUND RATING CALCULATOR is based on data gathered from hundreds of lighting installations over a period of many years. It provides a reliable index of the magnitude of audible ballast sound when room variables such as size, ceiling materials, and number of fixtures and ballasts are known. These calculations are keyed to . . .

GENERAL ELECTRIC'S BALLAST SOUND RATING SYSTEM. This system, initiated by General Electric in 1951, establishes a rigid scale of sound magnitude. Most General Electric ballast designs are carefully compared with this scale in actual fixture tests conducted in the only known anechoic sound chamber in the ballast industry. Each ballast design is thus "Sound-rated" "A" through "F," . . . "A" being quietest, and "F" being least quiet.

The sound-rating scale—and for that matter, the whole sound-control program—is not an industry standard. General Electric has established its own sound standards, and compares the performance of *General Electric ballasts* with these standards.

But the Sound-control Program doesn't end here. In order to give you further assurance that you get the "quiet" you specified, General Electric has established an elaborate . . .

DAILY PRODUCTION SOUND AUDIT. A *daily* sample of production units is carefully compared in sound performance with the G-E sound-rating standard—under controlled conditions in the anechoic sound chamber. This close check on possible manufacturing variations means you get the kind of sound performance that your Sound Rating Calculator promised. The final element in G.E.'s Sound-control Program is . . .

BASIC ENGINEERING DESIGN. General Electric ballast design engineers are constantly examining today's ballast circuitry, trying to further minimize the inherent magnetic "hum" of core and coil assemblies. An example of the results of this engineering effort is the recently announced "A" sound-rated 40-watt, rapid-start line. This popular family of General Electric ballasts was granted a G-E "A" sound rating as a result of *basic circuit design* that produced a smaller and quieter core and coil.

Materials are also an important sound-control factor. For example, the resilient asphaltic filling compound used in General Electric ballasts maintains excellent sound-absorbing characteristics over the entire life of the product. The new General Electric Bonus Line† ballasts, using this proved asphaltic filling compound, are designed to provide protection against objectionable ballast end-of-life leaking and smoking, without sacrificing any sound performance.

All this means that General Electric is truly concerned about ballast sound—and is investing heavily so you can stop being concerned with it yourself. Mail the coupon today for your General Electric Sound Rating Calculator, and start using it immediately. For more details, ask your local General Electric Ballast Sales Engineer, or write Section 403-02, General Electric Company, Schenectady 5, New York.

† Trade-mark of General Electric Company.

GENERAL ELECTRIC SOUND RATING CALCULATOR

This ingenious device was designed so you can always predict *with 100% accuracy* whether a lighting installation will present noise problems. You can use it for any indoor lighting application from extra-quiet broadcast studios to noisy offices. On the easy-to-use circular slide rule you simply (1) dial in room "constant," (ability of room to absorb noise); (2) number of ballasts and their sound rating and (3) given ambient noise level for your application. Steps 1 and 3 are *immediately determined* from tables which are part of calculator.

PLEASE SEND ME THE FREE BALLAST SOUND RATING CALCULATOR

Mail coupon to: General Electric Co.,
Section C403-02, Schenectady 5, N. Y.

NAME_____

COMPANY_____

ADDRESS_____

CITY_____

STATE_____

* Copyright 1956, General Electric Co.

Progress Is Our Most Important Product

GENERAL ELECTRIC

You get high level light output... and keep on getting it... when fixture ballasts wear this emblem!

That's one of the end results assured by the rigid CBM specifications... with conformance checked by test at Electrical Testing Laboratories

CBM Ballasts are checked by tests regularly, at E.T.L.

Other practical benefits include longer lamp life, longer ballast life, power factor correction, positive starting, dependable operation. Naturally you get UL listing, too. It all adds up to this: *you get more value when you insist on Certified CBM Ballasts* in fixtures you specify or install. For news and facts on fluorescent lamp ballasts, ask us to send you "CBM NEWS".

Write CERTIFIED BALLAST MANUFACTURERS, 2116 Keith Bldg., Cleveland 15, Ohio.

4-61

Participation in CBM is open to any manufacturer who wishes to qualify.

(Continued from page 24A)

has been announced. The company also named **John B. Orr** as director of its newly-formed Division of Research and Development.

A Certificate of Distinguished Service was presented by the Illuminating Engineering Research Institute to **O. R. Doerr,** on his retirement as IERI Trustee, "in grateful recognition of his dedicated contributions to the progress of lighting science in his role of Trustee of this Institute from 1957 through 1960."

Taylor M. Barr (M) retired July 31, after 38 years with Central Hudson Gas and Electric Corp., Poughkeepsie, N. Y., as lighting representative and consultant. Mr. Barr is the 1960-1961 Chairman of IES Board of Examiners on which he has also served as a member. In addition he was a member of the Farm Lighting Committee for many years, and IES local representative in Poughkeepsie.

Donald C. McCormack (M) was appointed director of research and product development (formerly manager of product development and engineering), of J. A. Wilson Lighting Ltd., Toronto, Ont. **Hedley F. Davidson** (F), most recently chief engineer for Curtis-AllBrite Lighting Ltd., Toronto, has joined the company as manager of engineering.

Smithcraft Corp., Chelsea, Mass., announced the selection of **Dan E. Dunne** (M) as manager of marketing. Mr. Dunne's new responsibilities will include direction of sales organization, customer service and advertising.

The Benjamin Division of Thomas Industries Inc., Des Plaines, Ill., named **Harry Shubart** as director of manufacturing. Mr. Shubart was chief engineer with the Emil J. Paider Co.

Merchandising manager post at Litecraft Manufacturing Corp., Passaic, N. J., was given to **David F. Nicholas.** He previously managed sales promotion and advertising for commercial lighting with Lightolier, Inc., Jersey City, N. J.

According to K. C. Dorland, general sales manager, The Union Metal Manufacturing Co., Canton, Ohio, **Calvin Friar** (A) has been appointed manager-outdoor lighting products. He was formerly assistant manager of the firm's northern California-northern Nevada district.

Joseph Belser, Samuel Tulchinsky, Fereydoon Ghaffari and **Victor Preston** were named associates by Victor Gruen Associates, architectural-engineering plan-

(Continued on page 28A)

SCHEDULED EVENTS

Dates of Interest to IES Members

August

August 21-23—National Association of Lighting Maintenance Contractors, National Convention, Flamingo Hotel, Las Vegas, Nev.

August 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco, Calif.

August 23-25—American Institute of Electrical Engineers, Pacific General Meeting, Salt Lake City, Utah.

September

September 14-15—Engineering Management Meeting, sponsored by AIEE and ASME, Hotel Roosevelt, New York, N. Y.

September 18-20—Standards Engineers Society, Tenth Annual Meeting, Hotel Sherman, Chicago, Ill.

September 24-29—Illuminating Engineering Society, National Technical Conference, Chase-Park Plaza Hotel, St. Louis, Mo.

September 25-28—Industrial Building Exposition & Congress, New York Coliseum, New York, N. Y.

October

October 1-6—Society of Motion Picture and Television Engineers, Semi-Annual Convention, Lake Placid Club, Lake Placid, N. Y.

October 3-5—Lighting Progress Exposition, sponsored by Electrical League of Southern California, Hollywood Palladium, Hollywood, Calif.

October 3-5—Delaware Valley Electrical Progress Show, Convention Hall, Philadelphia, Pa.

October 4-6—Canadian Electrical Manufacturers Association, Annual Meeting, Sheraton-Brock Hotel, Niagara Falls, Ont.

October 4-6—International Association of Electrical Leagues, Annual Conference, President Hotel, Atlantic City, N. J.

October 8-10—United States National Committee, CIE, Annual Meeting, Olentangy Inn, Columbus, Ohio.

October 9-11—Annual National Electronics Conference, International Amphitheatre, Chicago, Ill.

October 10-12—American Standards Association, National Conference on Standards, Rice Hotel, Houston, Texas.

October 10-13—National Electrical Contractors Association, Annual Convention and Exposition, Washington, D. C.

October 15-20—American Institute of Electrical Engineers, Fall General Meeting, Detroit, Mich.

October 18-20—Optical Society of America, Annual Meeting, Biltmore Hotel, Los Angeles, Calif.

November

November 6-8—National Warm Air Heating and Air Conditioning Association, Annual Convention, LaSalle Hotel, Chicago, Ill.

November 16—National Electrical Manufacturers Association, Annual Meeting, Summit Hotel, New York, N. Y.

November 24-29—1961 Electrical and Home Appliance Show, Electric Building, Balboa Park, San Diego, Calif.

January 1962

January 22-25, 1962 — National Plant Maintenance & Engineering Show, Convention Hall, Philadelphia, Pa.

January 25-27, 1962—National Society of Professional Engineers, King Edward Hotel, Jackson, Miss.

January 29-February 2, 1962—Electrical Engineering Exposition, sponsored by the American Institute of Electrical Engineers, New York Coliseum, New York, N. Y.

January 30-February 2, 1962—Society of the Plastics Engineers, Annual Technical Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

New IES Headquarters' Address After September 1st

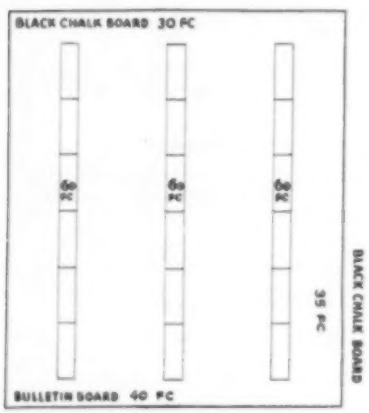
After September 1st, when IES Headquarters moves into the United Engineering Center, its address will be: Illuminating Engineering Society, 345 East 47th St., at United Nations Plaza, New York 17, N. Y.

Re: Experiment in School Lighting

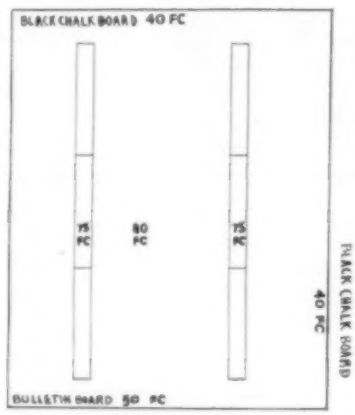
A misunderstanding has arisen in regard to the interpretation of footcandle values cited in the article "Experiment in School Lighting," page 378, June IE. The article, describing a comparison of 425- and 800-ma lighting systems in a classroom, contained a table which showed the *calculated* lighting level for each system to be 60 footcandles. Actual measured footcandle values, however, as shown in the drawing accompanying the article (data reproduced on drawings below) indicated that only the *800-ma* system produced an average *measured* illumination level of 60 footcandles. Average measured lighting level for the 425-ma system was 47 footcandles. These figures are shown in the table at right.

Comparison of Classroom Lighting Systems

	3 Rows 425-ma Direct-Indirect	2 Rows 800-ma Semi-Indirect
No. of Units	18	6
Load (including ballast loss)	1656 watts	1500 watts
Lamp	F40T12/CW/RS	F96T12/CW/RS
Lamp Lumens	2900	8700
Total Lumens	104,400	104,400
No. of Sockets	72	24
Equipment Cost	$428.58	$313.86
Room Index	E	E
C.U.	.56	.56
Area	24 x 28 ft. = 672 sq. ft.	
Ceiling Height	9 feet, 2 inches	
Average Measured Footcandles	47	60



425-ma system.



800-ma system.

(*Continued from page 27A*)

ning firm, Beverly Hills, Calif. Mr. Belser headed the economics division; Mr. Tulchinsky, the electrical division; Mr. Ghaffari served as senior planner, and Mr. Preston as senior engineer.

Ralph E. Crockett (M) has become manager of the Virginia sales district of General Electric's Large Lamp Department, Cleveland, Ohio. He replaces **Dean N. Jenks** (M), who was transferred to Newton Upper Falls, Mass. Mr. Jenks will be manager of the New England sales district, succeeding **Carroll M. Snyder** (M).

Wakefield and Art Metal Lighting Division, Wakefield Corp., Vermilion, Ohio, has announced the appointment of **Donald J. Watson** (A) as its sales representative in the northern Florida area, serving the principalities of Jacksonville, Daytona Beach, Orlando and Tallahassee. Another Wakefield Corp. announcement was the appointment of two new sales representatives. **Hamer K. Spencer** will cover the state of Virginia, with offices in Portsmouth, Va. **Richard Y. Fernandez** (A) will cover the eastern gulf coast section of Florida. He will be at the firm's office in Madeira Beach, Fla.

Robert S. Rogers is the newly chosen manager-national accounts, Large Lamp Products, Lighting Products Division of Sylvania Electric Products Inc., New York. Mr. Rogers succeeds **Raymond P. Connors** (A), who held this post until his death in March.

Thomas Industries Inc., Louisville, Ky., reported four appointments to Lighting Division sales positions. **Gilbert W. Allen** (A) will be district sales engineer at Charlotte, N. C.; **Clifford W. Kuhlman** (A) succeeds Mr. Allen as sales representative at Birmingham, Ala.; **Roy E. Lemley** and **Robert J. Griffin** have joined the company as sales representatives with headquarters at Columbus, Ohio and Albany, N. Y.

W. A. Sager (A) was chosen as manager-marketing, lighting, for the General Electric Supply Co., Bridgeport, Conn. He succeeds **W. W. Booth** (M), who retired on April 1 after more than 34 years of service.

Willard S. Ferris has been appointed general sales manager of Champion Lamp Works, division of Consolidated Electric Lamp Co., Lynn, Mass. Mr. Ferris previously was a sales executive at Bomac Laboratories, division of Varian Associates. Also appointed by Champion was **Douglas H. Davis** as assistant sales manager. He most recently served as vice-president and sales manager with the George H. Wahn Co.

NEW MEMBERS

The following is a partial listing of Associate and Student members elected to IES at the August 4 meeting of the Council Executive Committee. The complete list of elections will be published in the September issue of IE.

ALABAMA SECTION

Associate Member:

Peters, R. W., General Electric Supply Co., Birmingham, Ala.

ARIZONA SECTION

Associate Member:

Evans, J. H., Edward L. Varney & Associates, Architects, Phoenix, Ariz.

BLUE RIDGE CHAPTER

Associate Members:

Graham, A. L., Jr., Appalachian Power Co., Pulaski, Va.

Higgins, J. D., Appalachian Power Co., Fieldale, Va.

Reynolds, C. L., Appalachian Power Co., Roanoke, Va.

Smythers, H. M., Appalachian Power Co., Roanoke, Va.

BRITISH COLUMBIA SECTION

Associate Members:

Wallis, Keith, International Power & Engineering Consultants, Ltd., Vancouver, B. C.

CHICAGO SECTION

Associate Members:

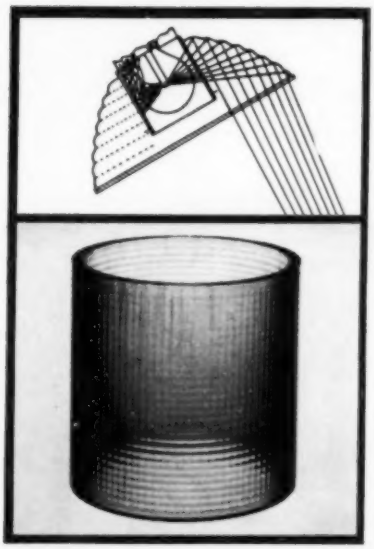
Contos, P. G., Bureau of Electricity, Department of Streets and Sanitation, City of Chicago, Ill.

Hahn, E. K., Central Illinois Electric & Gas Co., Rockford, Ill.

(*Continued on page 38A*)

Glass for lighting

CORNING'S ANSWERS TO A FEW LIGHTING PROBLEMS



NEW BLUE AKLO® CYLINDER ABSORBS 99+% OF IR

If there's ever a man you want to keep comfortable, it's a surgeon. So, you take extra pains with his lighting.

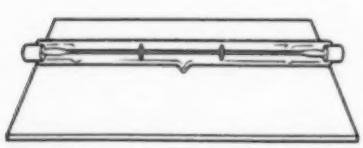
You want to correct his light to daylight. You want both him and his patient to stay as cool as possible.

A new AKLO filter which we make does both. It takes 2900°K light from incandescent lamps and corrects it to 4000°K. It absorbs all but a niggling less than 1% of the lamp's infrared, hardly enough to raise the temperature of a flea.

Add this to a cylinder that has been designed to be used with clear lamps and you get smooth, reproducible results every time the unit is re-lamped.

Filtering like this recommends itself for lighting, for photoengraving and photography, theaters, movies, television—in short, any place where you have light- and heat-conscious customers.

Check the coupon, if you're interested.



PROTECTING IODINE CYCLE LAMPS

All the recent interest in those radically new iodine cycle lamps has brought us a number of sticky problems. We've solved them.

We can now give you a glass lens that will sit for hours in an icy rain and then leap to 200°C when you light the lamp . . . without cracking or buckling.

The glass will also take untold weathering without wearing or discoloring, so you can assure customers of constant light down through the years.

We can work any special optical features you want into the glass. You can have it clear, diffused, or prismatic. You set the sizes and shapes and quantities.

Coupon.

HOW TO GET ONE FOR TWO ON KEROSENE CHIMNEYS

For years and years now we have provided two different chimneys for the railroad people to use with kerosene signals.

One looked like this.

It was for people who had springs that snapped on the lip of the chimney.

The other looked like this.

It was for people who had springs that snapped into indentations on the chimneys.

Sometimes the same people would use both, have to buy and stock both.

We came up with a design that looks like this.

As you can see, it can be used with both types of fixture. Now we make only one kind of chimney. The customers buy and stock only one kind. Everybody saves money. Everybody has fewer problems. That's progress.

We like simplifying things. We also like complexing things when it makes sense. We're flexible.

Try us either way when you have a lighting problem.

Start with the coupon, if you're interested in chimneys.

HOW CROUSE-HINDS DOLLED UP ITS EXPLOSION-PROOF FIXTURES

Nothing stimulates sales like having something new. When the thing that's new is also more useful, you've really got a winner.

Most people think this new Crouse-Hinds configurated globe *looks* better than its clear-glass predecessors. It also works better.

We helped.

The fluted pattern reduces glare and spreads the light more uniformly.

We put the flutes inside the globes, so there are no dust catchers. Cuts maintenance way down.

When you want something new to talk about, let us help you work over your lighting products.

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS, 6108 Crystal Street, Corning, N.Y.

Please send information on:

- ☐ AKLO filters
- ☐ Iodine lamp lenses
- ☐ Kerosene chimneys
- ☐ Explosion-proof globes

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

New

CROUSE/HINDS

QUARTZ-beam® FLOODLIGHT

Designed to maintain operating position and thermal level essential for proper self-cleaning of iodine-cycle lamps, QUARTZ-beam QFL-15 projects per-unit-area maximum of lamp's 33,000 lumen output. Provides constant unfading output of clean, white light, with candlepowers up to 200,000, and an average lamp life of 2,000 hours.

Three beam spreads available, with minimum vertical angle as narrow as 13°. Reflector is one piece die-formed, polished or etched. Cast aluminum door and housing sealed by silicone rubber gasket. Heat and impact resisting lens. Door locks tightly and releases quickly by means of 4 wing-nut clamps.

External raintight fuseholder (with fuse). Aiming and leveling device, exterior focusing screws included. Trunnion or slip fitter mounting. Hood, louvers and special mounting bases available. Get further information from your Crouse-Hinds distributor.

concentrates in sharp rectangular patterns the high-lumen output of 1500 watt Quartz-Iodine lamps

Type QFL-15 1500 W.
Ask for Bulletin 2729

Type QFL-8 500 W.
Ask for Bulletin 2725

CROUSE/HINDS
SYRACUSE NEW YORK

OFFICES: Atlanta Baton Rouge Birmingham Boston Buffalo Charlotte Chicago Cincinnati Cleveland Corpus Christi Dallas Denver Detroit Houston Indianapolis Kansas City Los Angeles Milwaukee New Orleans New York Omaha Philadelphia Pittsburgh Portland, Ore. St. Louis St. Paul Salt Lake City San Francisco Seattle Tampa Tulsa Washington
RESIDENT REPRESENTATIVES: Albany, N.Y., Baltimore, Md., New Haven, Conn., Reading, Pa., Richmond, Va.
Crouse-Hinds of Canada, Ltd., Toronto, Ont. Crouse-Hinds-Domex, S.A. de C.V. Mexico City, D.F. Peterco, Sao Paulo, Brazil

PUBLICATIONS

of the

ILLUMINATING

ENGINEERING SOCIETY

The Publications of the Illuminating Engineering Society listed here summarize the vast amount of research, investigation and discussion of hundreds of qualified members of the Society working on technical committees, and carry the full approval and authority of the Illuminating Engineering Society.

I.E.S. Publications are available, in single copies as priced, to anyone requiring knowledge of the newest in lighting application and the supporting technical information. Should quantities be desired for further distribution, such as for educational or promotional purposes, prices may be obtained by writing Publications Office.

This is your order form. Indicate number of copies ordered before each item; fill in name and address on back of form; enclose check/money order.

I.E.S. LIGHTING HANDBOOK Third Edition

NEWEST of famous I.E.S. Lighting Handbooks. Published March 1959. Over 1100 pages latest information on lighting techniques, applications and theory . . . plus equipment data. Includes all new lighting levels developed from Illuminating Engineering Research Institute studies. All-new index and cross-index. Application sections rearranged for subject headings; 25 sections in all, many new. Complete revision of previous two editions; more comprehensive, easier to use than ever.

Designed for use of lighting engineers and specialists; lighting consultants, architects, designers . . . anyone who plans, installs, or manufactures lighting systems or equipment.

___ **HB-3** **$10**

Add 50¢ for mailing outside U.S. and Canada. Special registered single copy price to I.E.S. members, $7.50; unless previously ordered. Quantity prices on request.

I.E.S. RECOMMENDED LIGHTING PRACTICES

These booklets are the complete, standard recommendations for lighting the prescribed areas, and are among the most comprehensive and important of all Society publications. As indicated, some of these recommendations are the work of committees of the American Standards Association, with collaboration by appropriate committees of the I.E.S. All have the approval of the Council of the Illuminating Engineering Society, and are the latest official I.E.S. recommendations.

In general, the information contained in these Recommended Lighting Practices covers completely the area shown in the title. Included in the data are suggested types of lighting systems and luminaires; levels for general lighting and for specific areas; analyses of seeing tasks; and other information essential to lighting the area and of value to lighting engineers and specialists, architects, construction people and others. Each practice is fully illustrated with charts and photographs.

___ **RP-1 Office Lighting** 1960: 36 pp. ..... **50¢**
___ **RP-4 Library Lighting** 1950: 16 pp. ..... **50¢**
___ **RP-6 Sports Lighting** 1961: 48 pp. ..... **50¢**
___ **RP-7 Industrial Lighting (A.S.A.)** 1952: 40 pp. ..... **50¢**
___ **RP-8 Street and Highway Lighting (A.S.A.)** 1953: 32 pp. ..... **50¢**
___ **RP-9 Supplementary Lighting** 1953: 16 pp. ..... **50¢**
___ **RP-10 Protective Lighting (A.S.A.)** 1956: 20 pp. ..... **50¢**
___ **RP-11 Residence Lighting** 1953: 44 pp. **$1.00**
___ **RP-12 Marine Lighting** 1959: 12 pp. ..... **50¢**
___ **RP-13 Outdoor Parking Area Lighting** 1960: 8 pp. ..... **50¢**
___ **RP-14 Airport Service Area Lighting** 1960: 8 pp. ..... **50¢**
___ **RP-15 Recommended Levels of Illumination** 1961: 16 pp. ..... **20¢**

RP-2 (Stores & Other Merchandising Areas), RP-3 (School Lighting) and RP-5 (Daylighting) are out of print. When revised publications are available they will again appear on this list.

I.E.S. COMMITTEE REPORTS

Lighting recommendations based upon studies (research, surveys of current practice, and experimental installations) of I.E.S. Committees and Subcommittees covering all phases of lighting. Completely illustrated, these reports contain detailed information on many lighting problems peculiar to the industry or operation involved as well as providing general data as to lighting systems and luminaires; recommended quantity and quality of illumination; and analyses of specific seeing tasks.

___ **CP-1 Lighting for Woolen and Worsted Textile Mills:** 12 pp. ..... **50¢**
___ **CP-2 Lighting for Machining of Small Metal Parts:** 16 pp. ..... **50¢**
___ **CP-3 Lighting for Flour Mills:** 8 pp. ..... **50¢**
___ **CP-4 Lighting for Canneries:** 36 pp. ..... **50¢**
___ **CP-5 Lighting for Bakeries:** 16 pp. ..... **50¢**
___ **CP-6 Lighting of Central Station Properties, Control and Load Dispatch Rooms:** 20 pp. ..... **50¢**
___ **CP-7 Lighting for Central Station High Bay Areas:** 12 pp. ..... **30¢**
___ **CP-8 Lighting Outdoor Locations of Central Station Properties:** 16 pp. ..... **40¢**
___ **CP-9 Lighting Indoor Locations of Central Station Properties:** 16 pp. ..... **40¢**
___ **CP-10 Lighting for Steel Mills, Part I: Open Hearth:** 8 pp. ..... **50¢**
___ **CP-11 Lighting for Foundries:** 16 pp. ..... **50¢**
___ **CP-12 Transportation Lighting:** 8 pp. ..... **25¢**
___ **CP-13 Lighting Traffic Tunnels and Underpasses:** 16 pp. ..... **50¢**
___ **CP-14 Lighting . . . Keyed to Today's Homes:** 86 pp. **$1.50**
___ **CP-15 Functional Visual Activities in the Home:** 12 pp. ..... **25¢**
___ **CP-16 Current Lighting Practice for Television Production:** 8 pp. ..... **15¢**
___ **CP-17 Progress in Television Studio Lighting:** 4 pp. ..... **10¢**
___ **CP-18 Current Lighting Practice for Color Television Production:** 4 pp. ..... **10¢**
___ **CP-19 Lighting for Commercial Kitchens:** 8 pp. ..... **15¢**
___ **CP-20 Lighting for Hotels:** 42 pp. ..... **70¢**

I.E.S. LIGHTING DATA SHEETS

Each I.E.S. Lighting Data Sheet describes an actual, outstanding lighting installation, complete with photographs, drawings and engineering data. They are published in a series of 24 sheets each year, and current sheets cover such subjects as lighting for metalworking, textile, automobile and other industries; schools; stores; offices; drafting rooms; churches; auditoriums; banks; museums; indoor and outdoor recreational areas; streets and highways; and other special applications.

Printed on heavy gloss paper, punched for standard ring binder, data sheets are an excellent "idea" file for lighting people, consulting engineers and architects; ideal for promotional distribution by manufacturers and electric utilities.

I.E.S. Lighting Data Sheets are delivered throughout each year in groups of eight; three mailings for the entire 24-sheet series. First eight of each series are mailed for delivery in June; second eight in October; final eight in February of following year. Subscription, 24 sheets per set, $1.25; 10 or more sets, $1.00 each. Prices on minimum quantities of 100 individual sheets upon request to Publications Office.

___ **XXVI Series,** 24 sheets **$1.25**

The current 1961 Series; orders now being accepted for delivery as outlined.

___ **XXV Series,** 24 sheets **$1.25**
___ **XXIII Series,** 24 sheets **$1.25**
___ **LD-2 Home Lighting Ideas for Kitchens and Bathrooms,** 10 sheets ..... **50¢**

Special packet showing modern lighting for new and remodelled kitchen and bathroom areas; an important addition to any home lighting idea library.

___ **LD-3 Decorative Home Lighting Ideas,** 14 sheets **$1.00**

Packet featuring outstanding ideas for decorating with light; do-it-yourself instructions for fireplace, wall niche, shelves, drapery wall, etc.

[Sheets in LD-2 and LD-3 not included in annual Series.]

LIGHTING EDUCATION

Attractively prepared booklet for secondary school students. Supplements physics or science texts with 12 laboratory experiments specifically on light and lighting; easily performed with minimum equipment. Designed to interest young people in lighting and lighting careers.

___ **ED-1 Laboratory Activities with Light** 1959: 42 pp. **$1.00**

MEASUREMENT & TESTING GUIDES

The Society has published many different guides to testing, measuring and reporting a wide range of lighting information.

They cover photometric and electrical measurement of lamps; general photometry; tests of different varieties, etc.

A complete listing and prices may be obtained from Publications Office by checking here. ☐

ORDER FORM

Do not detach. Mail entire form. New list will accompany invoice.

To: **ILLUMINATING ENGINEERING SOCIETY**
Publications Office
345 E. 47th St., New York 17, N. Y.

Date .....

Send to me at the address shown below copies of I.E.S. Publications indicated elsewhere on this list:

(Please print or type)

Name ..... *If I.E.S. Member Your Section/Chapter* .....

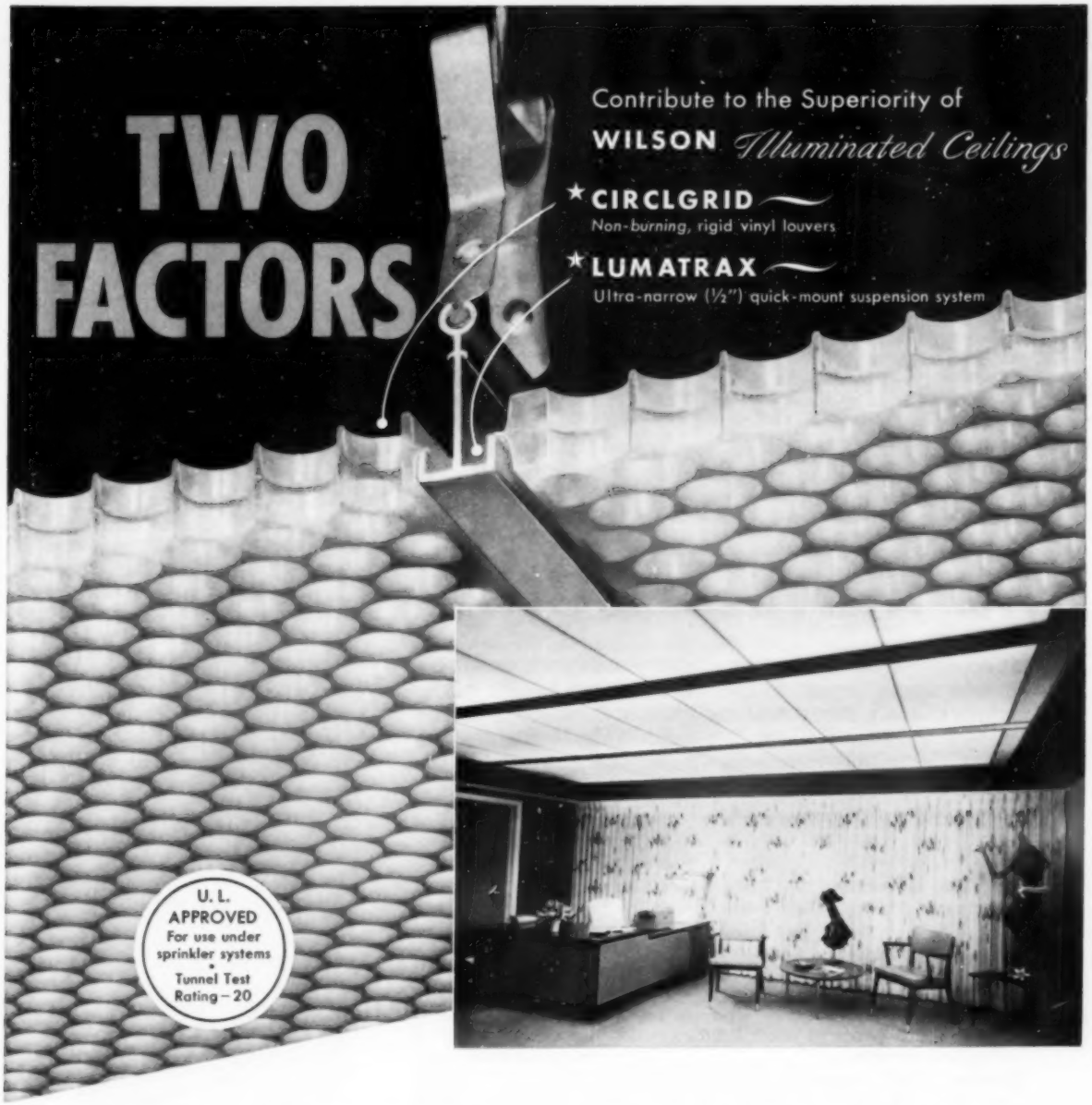
Street .....

City ..... Zone ..... State .....

☐ My check (m.o.) enclosed. ☐ Bill me.

For orders totalling $2 or less, please enclose check, money order or stamps with order. Prepayment will expedite handling and shipment to you.

(Printed in U.S.A.)



Ageless in beauty . . . versatile in performance, Wilson Illuminated Ceilings are rapidly becoming the architect's favorite lighting system for new construction or relighting.

★CIRCLGRID non-burning vinyl louvers feature thousands of tiny circles in transmitting soft diffused light, permitting intensities ranging to 200 foot candles. CIRCLGRID 2′ x 2′ and 2′ x 4′ panels consist of two non-combustible sheets of rigid vinyl electrically welded for great structural strength . . . with weight of only 3½ ozs./sq. ft.

These popular CIRCLGRID louvers meet rigid fire code standards for metropolitan buildings . . . they possess acoustical properties, permit air conditioning and sprinkler systems to function efficiently and the louvers are easily cleaned by rinsing in mild detergent.

★LUMATRAX exposed grid system offers the advantages of narrow support members and simplicity of installation. The tracks level quickly and perfectly by Wilson's exclusive spring clip. LUMATRAX is available in ½″ E track (straight or contoured) . . . and 15/16″ T track.

In other words, Wilson Illuminated Ceilings are recognized by leading architects and contractors as the outstanding system in the lighting field.

Write for Circlgrid and Lumatrax technical literature concerning the installation you are now working on.

J. A. WILSON LIGHTING
Peninsula Drive
ERIE, PENNSYLVANIA

WILSON

J. A. WILSON LIGHTING LTD.
280 Lakeshore Road
TORONTO 14, CANADA

International Wilson Affiliates
ENGLAND, Harris & Sheldon Electrical Ltd. • **AUSTRALIA**, Greendale Engineering Company
SOUTH AFRICA, New-Era Lighting • **MEXICO**, Quinzanos

from the frozen north... *to desert heat...*

AEROVOX BALLAST CAPACITORS ARE REALLY BUILT TO TAKE IT!

It's no wonder that the leading mercury and fluorescent lamp manufacturers, as well as the industry's top ballast manufacturers, are making Aerovox their first choice. Aerovox Multi-Section Ballast Capacitors are designed from the start to provide trouble-free, long-life service under wide extremes of ambient temperature . . . even at high altitudes. Look at these important features:

IMPREGNATED WITH HYVOL F® — a non-flammable synthetic impregnant especially suited to efficient AC capacitor design and function.

EXCLUSIVE WEATHER-GUARD 80-147 FINISH — provides maximum protection against rust and corrosion under all temperature and moisture conditions.

MULTI-SEALED AGAINST LEAKAGE — the unique terminal construction, special soldered fill hole, and double-locked seam with sealant between the cover and drawn steel container all add up to positive protection against impregnant leakage.

QUALIFIED APPLICATION ENGINEERING SERVICE AVAILABLE — Aerovox application engineers are ready at all times to serve you. Since Aerovox has long been a pioneer in capacitor design and manufacture, we offer years of experience and know-how for the discussion and analysis of your specific requirements.

NOW... 2 YEAR WARRANTY
ANOTHER AEROVOX FIRST!

AEROVOX CORPORATION
NEW BEDFORD DIVISION — NEW BEDFORD, MASS.

Technical Leadership — Manufacturing Excellence

FREE CATALOG
Aerovox AC Ballast Capacitors are available in a wide range of voltages and capacities. Call your local Aerovox representative today for your copy of our new catalog, or write direct.

NEW EQUIPMENT DATA

AVAILABLE FREE WITH RETURN CARD

New manufacturers' catalogs and bulletins listed below are available to IE readers who return card below. Clip out card, circle numbers wanted, print name and address plainly, affix 3-cent stamp and mail. Request will be forwarded promptly to manufacturer.

(1) INCANDESCENT DOWNLIGHTS New line of "Westinghouse by Frink" downlights described in 12-page catalog; features and application data for square, round, eyeball and small aperture styles for 75 to 300-watt lamps, includes photometric and other technical data. Frink Corp., Brooklyn, N. Y.

(2) CEILING PANELS Four-page brochure covers design of luminous ceilings with "Metalcel" steel, hexagonal-celled ceiling panels; contains photometric curves, c. of e. tables and related formula for calculating lumen values; shows application ideas. Fannon Products Div., Hupp Corp., Detroit, Mich.

(3) BALLASTS "Solid-Fil" development is described in four-page folder which explains features of company line of fluorescent ballasts. Also available cross-reference guide giving company numbers and corresponding numbers of other manufacturers. Advance Transformer Co., Chicago, Ill.

(4) SURFACE-MOUNTED FLUORESCENT 28-page Brochure A-6 features new "Contempo" series of shallow, surface-mounted fluorescent lighting fixtures with ten diffusing elements, for commercial application. Data includes specifications and installation instructions, as well as technical information. Globe Illumination Co., Los Angeles, Calif.

(5) GLASS New, full color, 20-page Bulletin 760 describes how special glass products are designed and produced with the proper combination of properties to meet specific application requirements. Kopp Glass Inc., Swissvale, Pa.

(6) UPLIGHT UNITS Catalog pages 18A and 18B describe and give performance data for new porcelain enameled uplight units for mercury and incandescent lamps to be used in medium- and high-ceilinged areas such as gymnasiums, power plants, foundries, etc. Abolite Lighting, West Lafayette, Ohio.

(7) RECESSED INCANDESCENT Three new 13" square, ceiling-recessed, incandescent luminaires with prismatic glass reflectors and lenses are described in new six-page brochure which also includes photometric and illumination data as well as specifications. Holophane Co., Inc., New York, N. Y.

(8) PLANNED LIGHTING MAINTENANCE Eight-page folder issued by national group tells how planned lighting maintenance can save money, increase efficiency; lists eight advantages obtained by using NALMCO members and lists member firms in U.S. and Canada. Nat'l Association of Lighting Maintenance Contractors, Cleveland, Ohio.

(9) RECESSED TROFFERS New 44-page illustrated catalog features line of modular troffer units with frameless plastic lenses and a wide variety of other shieldings; includes distribution curves and photometric data. Globe Lighting Products Inc., Brooklyn, N. Y.

(10) DECORATIVE DRUMS Eight-page Brochure 1856 introduces new series of flare-shaped drums as well as other shapes of hand-blown white opal glass, designed as decorative utility light in the home and commercial applications; gives specification and photometric data. Moe Light Div., Thomas Industries, Inc., Louisville, Ky.

(11) MERCURY LAMPS 16-page, spiral-bound brochure with illustrated transparencies tells features of "Bonus Line" mercury lamps; lists shapes and numbers for various applications; gives some technical information. General Electric Co., Cleveland, Ohio.

(12) RECESSED TROFFERS Three lines of recessed fluorescent troffers are shown in attractive, two-color, 36-page Brochure D-L, which also gives mounting, photometric and illumination data. Smoot-Holman Co., Inglewood, Calif.

(13) RESIDENCE FIXTURES New 68-page, full-color "Trendlighting" catalog describes 246 fixtures for every room in the home, plus outdoor lighting, and reflecting major home decorating trends both in new homes and for relighting. Emerson-Imperial, St. Louis, Mo.

(14) FLUORESCENT BALLASTS New 12-page "Buyer's Guide" lists company's line of fluorescent lighting ballasts for indoor and outdoor applications; shows electrical and mechanical specifications, including warranty, certifications and listings, operating voltages, etc. Sola Electric Co., Elk Grove Village, Ill.

(15) FLUORESCENT FIXTURES New complete catalog of fluorescent lighting fixtures, including four color-keyed sections, each covering a line of commercial or industrial units and giving specifications, installation and photometric details, suggested applications. Keystone Electric Mfg. Co., Philadelphia, Pa.

(See next page)

Offer good for two months only

Circle numbers wanted. Print name and address plainly. Affix 3-cent stamp and mail.

8-61

To ILLUMINATING ENGINEERING

Please have sent to me at address below, without further obligation, items circled below:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29							

Name_____

Company_____

Street_____

City_____ Zone_____ State_____

Not good after October 30, 1961

(16) EXITS Two-color, four-page folder describes company's newly designed exit lights for incandescent or fluorescent lamps, or electroluminescence; explains new design and flexibility of mounting features. Edwin F. Guth Co., St. Louis, Mo.

(17) AIR-HANDLING TROFFER 20-page, two-color brochure covers subject of "Sylva-Flo" combination air-handling troffers for lighting and air-conditioning; contains many illustrations, specification details, with table and charts giving photometric and air distribution data. Sylvania Electric Products Inc., Wheeling, W. Va.

(18) FLUORESCENT LAMP BALLASTS Company offers new 16-page illustrated "Manual of Fluorescent Lamp Ballasts" featuring special section on care and operation with recommendations for obtaining proper performance; contains description of various types, design, construction and applications. Universal Mfg. Co., Paterson, N. J.

(19) WEATHERPROOF LUMINAIRES New four-page Catalog PB61 illustrates new line of weatherproof prismatic wall brackets and ceiling fixtures for residential, commercial and industrial applications, including decorative opal designs. Stonco Electric Products Co., Kenilworth, N. J.

(20) HOSPITAL BED LIGHT Catalog sheets describe newly-designed "Tranquilite" series of fluorescent units for hospital bed lighting and companion "Utility" series units for other commercial and industrial installations; gives specifications and distribution curves. Day-Brite Lighting, Inc., St. Louis, Mo.

(21) FLUORESCENT LAMPS "New Light, More Light," four-page folder covers features of new line of "High Efficiency" fluorescent lamps said to provide up to 36% more light at no extra cost through use of special zinc silicate phosphors. Westinghouse Electric Corp., Lamp Div., Bloomfield, N. J.

(22) COMMERCIAL FLUORESCENT UNITS Attractive folder describes "Slenderline" series of slim, surface-mounted fluorescent luminaires for 2, 4 or 6 rapid-start, 40-watt lamps, with a selection of diffusers and for a wide variety of commercial applications. Solar Light Mfg. Co., Chicago, Ill.

(23) CHURCH LIGHTING Catalog No. 74 shows in color company's complete line of decorative luminaires designed for church use and available in many choices of finish and color; gives specifications and suggestions on church lighting. NL Corp., Cleveland, Ohio.

(24) PENDANT SYSTEMS Four-page folder in two-colors new "Lok-Electric" pendant luminaires designed for integration with company's aluminum suspended ceiling and using 1500ma lamps; tells features and specifications, including photometric data. Lok-Products Co., Los Angeles, Calif.

(25) AREA FLOODLIGHTING Bulletin 2719 "Area Floodlighting Made Easy" in 16-page brochure gives quick reference guides for floodlight selection and determining number required for given areas such as parking areas, construction sites, shopping centers, etc.; shows many types with specifications and distribution data on each. Crouse-Hinds Co., Syracuse, N. Y.

(26) "MONOCITE" SHIELDS Brochure A-15526 tells how "Monocite" methacrylate monomer shields or panels can be used to light for mood, area or type of work to be performed; lists typical properties and presents some examples of use of these sheets. E.I. du Pont de Nemours & Co., Wilmington, Del.

(27) BALLASTS Four-page publication GEA-6912 lists features of new "Bonus" line fluorescent lamp ballasts; describes non-resetting thermal protector and capacitor; gives tables of ratings, data and dimensions. General Electric Co., Schenectady, N. Y.

(28) NEW FLOODLIGHT LINE Bulletin GF 860 is announcement of new "Generalflood" floodlight; describes design features such as ease of servicing, self-centering inner reflector, and filter wick to keep reflector and cover glass free of dirt and condensation; includes sizes and photometric data. Appleton Electric Co., Chicago, Ill.

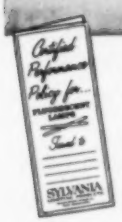
(29) COMMERCIAL INCANDESCENT New 76-page catalog illustrates and describes complete line of commercial incandescent lighting fixtures, includes full description of prismatic lens units with light distribution curves and photometric data. Line includes wall lights, pendants, exits, etc., all shown in color, and suggested applications. Art Metal Lighting Div., Wakefield Corp., Cleveland, Ohio.

PLACE 3¢ STAMP HERE

ILLUMINATING ENGINEERING SOCIETY
United Engineering Center
345 East 47th St.
New York 17, N. Y.

Herewith a return of IE's popular feature describing valuable new literature about a wide choice of lighting equipment and services. The already addressed return card is something new to make it easier for IE readers to request the information. Use this service to bring your lighting equipment file up to date.

to give you your money back



Have *you* read the Sylvania guarantee?

"If at any time a Sylvania Fluorescent Lamp fails in your opinion to provide better performance than any other brand fluorescent lamps, on the basis of uniformity of performance, uniformity of appearance, maintained brightness and life, it may be returned to the supplier for *full refund of purchase price.*"

(Only Sylvania dares to back its fluorescent lamps with anything like this remarkable Certified Performance Policy.)

This guarantee of quality is your assurance, too, that Sylvania actually lowers your TCL (Total Cost of Lighting), which means cost of lamps *plus* power *plus* maintenance.

Want better light? Want to be *sure* you're buying it? Call your Sylvania representative. Or write us:

Lighting Division, Sylvania Electric Products Inc., Dept. 01, 60 Boston St., Salem, Mass. In Canada: Sylvania Electric (Canada) Ltd., Montreal.

SYLVANIA

Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**

PREPRINTS OF I.E.S. NATIONAL TECHNICAL CONFERENCE PAPERS MAY BE ORDERED NOW

Packets will be mailed to Home or Office during or after the Conference in September. For Conference use, purchase at Registration Desk

Preprints of the technical papers being presented at the forthcoming 1961 I.E.S. National Technical Conference at St. Louis, Mo., September 24-29, will be available by mail order from the I.E.S. Publications Office as usual.

These preprints present all that is new in the theory and techniques of modern lighting and are an invaluable source for reference and information whether you attend the Conference or not. For Delegates to the Conference, preprints are essential and should be obtained at the Registration Desk immediately upon arrival. For those not attending, the preprints are also important for file and reference and should be ordered by using the coupon below.

Preprint packets for use at the Conference:

Due to necessary last-minute printing, no pre-Conference mailing can be made. Packets for use at the sessions will be sold at the Conference Registration Desk, cash-and-carry—$3 per set.

Preprint packets to be mailed:

Use this order form *only* if you want the preprints to be mailed to your Home or Office. Mail delivery there will be during or after the Conference—$4.00 per set.

Please do not use this order form for delivery of I.E.S. Conference Preprints at the Conference. Purchase at Desk.

Publications Office
ILLUMINATING ENGINEERING SOCIETY
345 E. 47th St., New York 17, N. Y.

When available mail..... set(s) 1961 National Technical Conference Preprints at $4.00 per set to address below:

Name.....

Address.....

.....

.....

☐ **Check (M.O.) enclosed** ☐ **Bill me** IES

(*Continued from page 28A*)

March, H. S., The Pyle-National Co., Chicago, Ill.

CLEVELAND SECTION

Student Member:
Cascio, R. L., Case Institute of Technology, Cleveland, Ohio.

CONNECTICUT SECTION

Associate Member:
Newcomb, E. C., Pratt and Whitney Aircraft, East Hartford, Conn.

DIABLO SECTION

Associate Members:
Fearon, R. L., Pacific Gas & Electric Co., Oakland, Calif.
Keyser, J. C., Pacific Gas & Electric Co., Oakland, Calif.
St. Clair, Vaughn, Guaranteed Lighting, Fremont, Calif.

FLORIDA SECTION

Associate Members:
Scott, J. N., Florida Power & Light Co., Sarasota, Fla.
West, P. C., Brockman Electric Supply, Inc., Sarasota, Fla.
Willis, H. M., Florida Power & Light Co., Venice, Fla.
Wolvin, Elizabeth, Florida Power Corp., St. Petersburg, Fla.

FOREST CITY (LONDON) CHAPTER

Associate Member:
Forman, J. R., Dow Chemical of Canada, Ltd., Sarnia, Ont.

GEORGIA SECTION

Associate Member:
Trudeau, C. B., Lustra Corp. of America, Atlanta, Ga.

GOLDEN GATE SECTION

Associate Members:
Worsley, J. C., J. C. Worsley, Architect, Menlo Park, Calif.
Yonovitz, Robert, J. Marion Thomas & Associates, San Francisco, Calif.

GULF STREAM CHAPTER

Associate Member:
Eastham, R. V., Florida Power & Light Co., West Palm Beach, Fla.

HEART OF AMERICA SECTION

Associate Members:
Davis, H. C., Jackson County Electrical Enterprises, Inc., Independence, Mo.
Foley, J. R., Parkins & Brets Co., Kansas City, Mo.
Kerrick, T. E., Atomic Energy Commission, Kansas City, Mo.
Steele, H. S., General Electric Supply Co., Kansas City, Kans.

Student Members:
Adams, J. M., Finlay Engineering College, Kansas City, Mo.
Lanaman, J. H., Finlay Engineering College, Kansas City, Mo.
Rankinen, R. E., Finlay Engineering College, Kansas City, Mo.
Roark, G. E., Finlay Engineering College, Kansas City, Mo.
Smith, W. K., Finlay Engineering College, Kansas City, Mo.

IOWA SECTION

Student Members:
Fridley, Jo Ann, Iowa State University, Ames, Ia.
Nordman, Joyce, Iowa State University, Ames, Ia.
Okuna, Margaret, Iowa State University, Ames, Ia.
Walter, Ruth, Iowa State University, Ames, Ia.

KENTUCKIANA CHAPTER

Associate Member:
Hawse, L. E., Duro-Test Corp., Valley Station, Ky.

(*Continued on page 40A*)

Ceiling for the new California Bank main branch in Los Angeles. Interior designer, Henry Dreyfuss. Installed by Harold E. Shugart Co., Los Angeles. Ceiling made from BAKELITE Brand rigid vinyl sheet panels by Cepco, Inc., San Francisco, California.

A Bank Draws High Interest On Its
LONG-TERM INVESTMENT IN LIGHTING

There's a friendly, refreshing note in this Los Angeles bank's brilliant lighting. Glare-free and shadowless, the luminous ceiling is a snowy expanse of translucent BAKELITE rigid vinyl sheets suspended beneath fluorescent fixtures. The huge panels, four feet square, consist of a top and bottom sheet with an air space between and are placed in a metal frame under tension to facilitate handling. For years to come, the ceiling will stay as beautiful as it is. Accelerated aging tests show high resistance to ultra-violet light.

Now . . . high impact resistance! BAKELITE rigid vinyl sheets are now available with *new high impact qualities* that provide extra resistance to hard knocks . . . the wear and tear of installation and maintenance . . . cracking and warping. These sheets are normally unaffected by moisture and detergents, and, because of their light weight, they are easy to install, remove, and maintain.

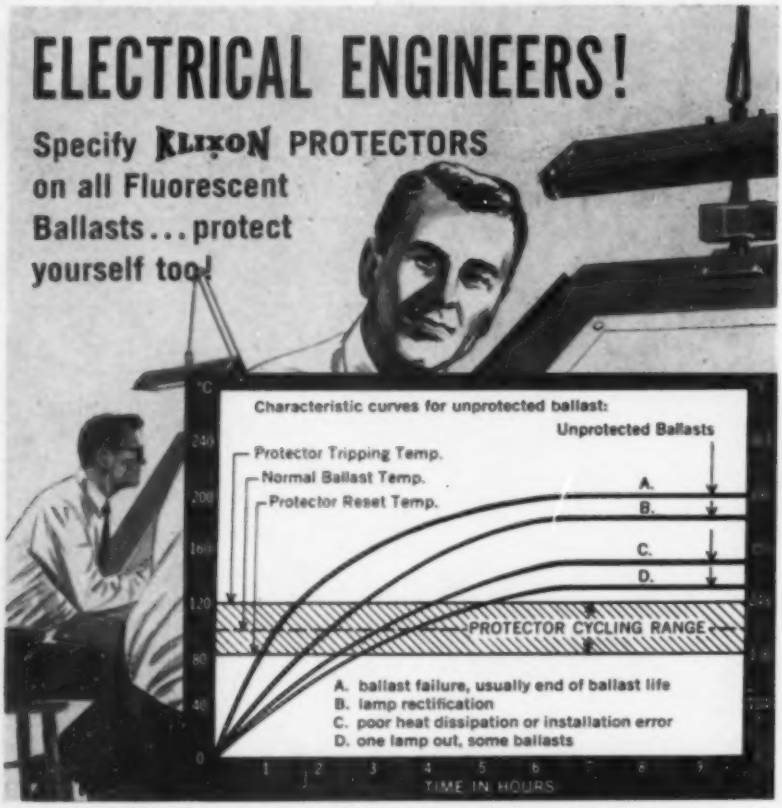
New designs or renovations can be given a lift with better lighting. Install luminous ceilings made with *high-impact* BAKELITE rigid vinyl sheet. For information, write Dept. IV-72G, Union Carbide Plastics Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 12.

BAKELITE and UNION CARBIDE are registered trade marks of Union Carbide Corporation.

UNION CARBIDE

ELECTRICAL ENGINEERS!

Specify KLIXON PROTECTORS on all Fluorescent Ballasts... protect yourself too!



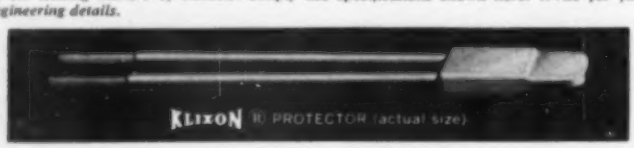
In the installation and operation of fluorescent fixtures (see chart) you can protect your own reputation and give your client important extra benefits at low, low cost . . . simply SPECIFY BALLASTS WITH KLIXON PROTECTORS!

KLIXON® PROTECTORS ASSURE . . .

- Ballasts and fixtures that operate within U/L temperature limits . . . positive protection against overtemperature, overcurrent, or both.
- Cool running installations . . . rapid response against overheat allows correction while contractor is still on job.
- Maximum ballast life . . . external faults can not cause dangerous overheating. When corrected, ballast operates normally again. An internal fault signals need for ballast replacement . . . with protector keeping temperature at a safe level until this is convenient.
- No dripping compound, fires or violent failures at end of ballast life.

These KLIXON benefits are not attainable with fuse protection. Ballasts under some fault conditions draw less than full rated current, still deliver light, but may have a case temperature twice the allowable U/L limit for normal operation. Thus BALLAST OVERHEAT PROTECTION is a TEMPERATURE, not a CURRENT problem.

Ballasts equipped with KLIXON Protectors can be supplied to your fixture manufacturer by all six leading makers of ballasts. Simply use specifications shown here. Write for full engineering details.



USE THIS KLIXON PROTECTION SPECIFICATION

"Ballast shall be thermally protected against overheating by a built-in automatic reset overheat protector sensitive to both winding temperatures and current which will prevent winding temperatures from exceeding 120°C with the exception that the peak temperatures in the first few cycles may exceed this. The protector must allow the winding temperatures to reach 105°C minimum under normal conditions in a 40°C ambient without opening the circuit to the primary winding, and after opening shall not reclose above 85°C. Fixtures must be so designed that ballast coil temperatures shall not exceed the U/L limit of 105°C in a 40°C ambient."

METALS & CONTROLS INC.
5408 FOREST STREET • ATTLEBORO, MASS.
A CORPORATE DIVISION OF
TEXAS INSTRUMENTS
INCORPORATED

(*Continued from page 38A*)

MARITIME CHAPTER

Associate Member:
Evans, J. H., New Brunswick Telephone Co., Ltd., St. John, N. B.

MARYLAND SECTION

Associate Members:
Lemel, Irvin, Department of Education, City of Baltimore, Md.
Smith, E. F., U. S. Army, Fort Holabird, Baltimore, Md.

MEXICO CHAPTER

Associate Member:
Gonzales, J. A., A. G. McKee de Mexico, S. A., Mexico City, Mexico.

MIAMI VALLEY SECTION

Associate Member:
Hoffman, C. J., Dayton Power & Light Co., Dayton, Ohio.

MICHIGAN SECTION

Associate Members:
McGonegal, R. A., Jackson Public Schools, Jackson, Mich.
Miner, J. L., J. J. Miner Co., Detroit, Mich.
Student Member:
Rivas, V. M., University of Michigan, Ann Arbor, Mich.

MID-SOUTH CHAPTER

Associate Members:
Eades, T. W., Gregory-Salisbury & Co., Inc., East Memphis, Tenn.
Randolph, J. M., Curtis H. Stout of Tennessee, Inc., Memphis, Tenn.

MILWAUKEE SECTION

Associate Members:
Bergmann, H. P., Wisconsin Power & Light Co., Janesville, Wis.
Woellert, L. N., Wisconsin Power & Light Co., Sheboygan, Wis.

MISSISSIPPI CHAPTER

Associate Member:
McPhail, E. S., Jr., Westinghouse Electric Supply Co., Jackson, Miss.

NEW ENGLAND SECTION

Associate Member:
Davis, J. G., Fitchburg Gas & Electric Light Co., Boston, Mass.
Student Member:
Warma, J. G., United Lighting Corp., Boston, Mass.

NEW YORK SECTION

Associate Members:
Berendt, Bohden, Watson-Flagg Engineering Co., New York, N. Y.
Kaadin, S. E., Gotham Lighting Corp., Long Island City, N. Y.
Susser, I. I., Capitol Lighting, Hackensack, N. J.

NORTHUMBERLAND CHAPTER

Associate Member:
Melanson, L. Y., Acme Electric, Ltd., Moncton, N. B.

NORTHWESTERN OHIO SECTION

Associate Member:
Ash, W. J., 4110 Templar, Toledo, Ohio.

OREGON SECTION

Associate Member:
Meier, C. M., Lighting Maintenance Co., Portland, Ore.

OTTAWA SECTION

Associate Member:
Pezoulas, Nicholas, Royal Canadian Air Force Headquarters, Victoria Island, Ottawa, Ont.

OZARK CHAPTER

Associate Members:
Barrett, J. W., Graybar Electric Co., Springfield, Mo.
Cunningham, R. D., Pittsburgh Plate Glass Co., Springfield, Mo.

PALMETTO SECTION

Associate Members:
Folsom, W. J., General Electric Co., Hendersonville, N. C.
Milam, R. A., Jr., General Electric Supply Co., Columbia, S. C.

PHILADELPHIA SECTION

Associate Members:
Conway, J. D., Conowingo Power Co., Elkton, Md.
Huffnagle, D. R., Philadelphia Electric Co., Philadelphia, Pa.
Rania, J. P., Robert Keough & Co., Philadelphia, Pa.
Rogerson, M. A., Pennsylvania Power Co., New Castle, Pa.

PITTSBURGH SECTION

Associate Member:
Ferry, J. R., Gerry Electric Co., Pittsburgh, Pa.

PUGET SOUND SECTION

Associate Members:
Bollong, J. W., J. W. Arch Bollong & Associates, Seattle, Wash.
Dillon, H. K., Electrical Products Consolidated, Seattle, Wash.

ST. LOUIS SECTION

Associate Member:
Bogel, G. D., Corning Glass Works, Webster Groves, Mo.

SAN DIEGO SECTION

Associate Members:
Ogden, R. J., California Electric Works, San Diego, Calif.
Shelton, R. M., D.P.W.O., San Diego, Calif.

SAN JACINTO SECTION

Associate Member:
McNamara, A. C., Wide-Lite Corp., Houston, Texas.

SOUTHERN CALIFORNIA SECTION

Associate Members:
Callender, R. E., Halo Lighting of California, Los Angeles, Calif.
Cummings, J. H., Halo Lighting of California, Los Angeles, Calif.
Harrison, L. L., Nevada Power Co., Las Vegas, Nev.
Jones, G. P., Halo Lighting of California, Los Angeles, Calif.
Pickar, Louis, Halo Lighting of California, Los Angeles, Calif.

TENNESSEE VALLEY SECTION

Associate Member:
Alexander, W. R., Morristown Power System, Morristown, Tenn.

TORONTO SECTION

Associate Members:
Hart, A. D., Powco Steel Products Ltd., Toronto, Ont.
Lenson, W. J., W. J. Lenson & Associates Ltd., Sault Ste. Marie, Ont.

TWIN PORTS CHAPTER

Associate Member:
Bergson, H. W., Westinghouse Electric Supply Co., Duluth, Minn.

WINNIPEG CHAPTER

Associate Member:
Baxter, F. D., Bancroft, Bodel & Inch Western Ltd., Winnipeg, Man.

NON-SECTION

Associate Members:
Fothergill, R. J., 9 Burnside, Newcastle Upon Tyne, England.
Joseph, R. S., Duro-Test International Corp., Caracas, Venezuela.
LaPlace, B. M., Claude Paz & Visseaux, Paris, France.

The MITCHELL MOTIF | A new concept in Controlled Brightness

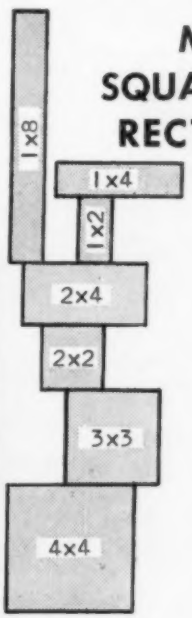
The "Control-lens" offered in Mitchell's MOTIF assures ideal low brightness illumination to provide the ultimate in comfortable visual environment. Not just a diffuser; but a lens of refractor prisms that directs high-level illumination without glare. The smartly styled shallow-profile of the MOTIF (apparent depth 2⅛" thin) lends itself to modern interiors. Write for complete engineering and photometric data.

MITCHELL LIGHTING DIVISION
COMPCO CORP., 1800 N. SPAULDING AVE.
CHICAGO 47, ILL.

The STRATA Series

by SECHRIST

MODULAR SQUARES and RECTANGLES



8 TYPES OF LIGHT CONTROL DEVICES
SHALLOW 3½" DEPTH

See Your Sechrist Representative or Write Us

SECHRIST
BOX 6775
Denver 16, Colorado
Leaders in Lighting . . . Since 1888

CIRCLGRID 45

LIGHT CONTROLLING VINYL LOUVERS

- Unique cellular design for rigidity and lightness—weighs only 3½ oz./sq. ft.
- 500 Circular openings/sq. ft. for circulation of cooling air
- Approved for installation under sprinklers
- Emits up to 25% more light than other louvers
- Self-extinguishing—UL rated 20 (Tunnel test)

PATENT APPLIED FOR IN U.S.A. AND FOREIGN COUNTRIES

Approved by building codes of most major cities

Office Area—Circlgrid Ceiling Total Area—10,000 Sq. Ft. Commission of Arizona

Circlgrid Luminous Ceiling installed in retail store

Circlgrid Luminous Ceilings cover 11,000 Sq. Ft. at Hamot Hospital's new addition.

CIRCLGRID goes where quality counts

Using the entire ceiling to enhance interiors gives the architect a new design horizon. Circlgrid light controlling louvers provide a pleasing permanent design that transforms the entire area into an efficient light source—eliminates glare concentrations common to conventional unit lighting. May we refer you to Circlgrid installations near you for your study?

SEE OUR CATALOG IN SWEET'S

Write for sample and test data

Address Box 655, Erie, Pa.

circlgrid plastics

Division—The Wilson Research Corp.

EMPLOYMENT OPPORTUNITIES

LIGHTING SALES ENGINEERS

Manufacturer since 1895 desires lighting sales engineers with following among Architects, Engineers, Distributors, etc. Engineered line of Commercial Fluorescent and Incandescent lighting fixtures. 78-page hard-back catalog. Corning and Holophane diffusers. Many territories open. Forward complete resume. State lines carried. The Kayline Co., 1241 E. 45th St., Cleveland 14, Ohio.

REPRESENTATIVES WANTED

The Mitchell Lighting Division seeks qualified representation for its full line of commercial, industrial, institutional and outdoor fluorescent lighting equipment. Applicant should be conversant with and have entry into the offices of architects and engineers or have public utility, distributor or contractor experience. Many territories are currently available. Send full details to Mitchell Lighting Division, 1800 North Spaulding Ave., Chicago 47, Illinois.

LIGHTING SALES ENGINEERS

Progressive manufacturer of architectural lighting equipment offers excellent opportunity for experienced men with knowledge of applied lighting:—To call on architects and engineers in New York City and metropolitan area. Send complete details in strict confidence—Gotham Lighting Corporation, 37-01 31st St., Long Island City 1, New York.

LIGHTING SALES REPRESENTATIVE

Progressive manufacturer of architectural lighting equipment seeks experienced sales representation in the State of Connecticut. Must have good lighting sales engineering background with knowledge of applied lighting, to call on architects and engineers. Furnish complete resume including lines presently carried —Gotham Lighting Corporation, 37-01 31st St., Long Island City 1, New York.

ELECTRICAL ENGINEER WANTED

To head Electrical Dept. in NYC Consulting Engineering firm. Lic NYS Prof. Engr. Minimum 10 years' design supervision on commercial and institutional buiuings. Excellent potential. Salary $10,000 up, commensurate with experience. Forward resume to Box 497, Publications Office, Illuminating Engineering Society, 345 E. 47th St., New York 17, N. Y.

ILLUMINATION ENGINEER

With varied and broad experience seeks position where his theoretical and practical knowledge and experience in photometry, optics, luminaire design and the functional application of indoor and outdoor lighting can be made productive. Teamed with his technical capacity is a keen analytical approach to problems. Working with people as well as coordinating activities and goals are a second nature to him. His participation in IES work will bring him to the Conference in St. Louis, during which stay he would like to have the opportunity to discuss a potential position. Please write your proposal to Box 498, Publications Office, Illuminating Engineering Society, 345 E. 47th St., New York 17, N. Y.

Custom designed
CHANDELIERS...

Bonhard's Interiors Cleveland, Ohio

for

Restaurants
Motels
Foyers
Banks
Hotels
Hospitals
Stores
Libraries

NL's lighting specialists, throughout the United States, are ready to serve you with lighting and design recommendations. Write for information.

NL Corporation formerly The Novelty Lighting Corporation
2490 EAST 22nd STREET—CLEVELAND 15, OHIO
DESIGNERS and MANUFACTURERS——SINCE 1905

Design Your Line With Gimbals in Mind
USE
ATI GIMBAL RINGS*

GIMBAL RING for PAR 38, 46, 56 and the 64 sideprong lamps.

GIMBAL RING for R30, R40 and PAR 38 screw-base lamps.

for More Sales Appeal
Versatility And Adaptability
Quality Features
Long Life Construction

*Cadmium plate, brushed chrome effect. Use as is or paint over.

Write or call for details

ATI ALEXANDER-TAGG INDUSTRIES, INC.
HATBORO, PENNSYLVANIA
OSborne 5-7200

I.E.S. LIGHTING HANDBOOK
Third Edition

No matter what edition of this "bible" of lighting you may have on your desk, it's out of date.

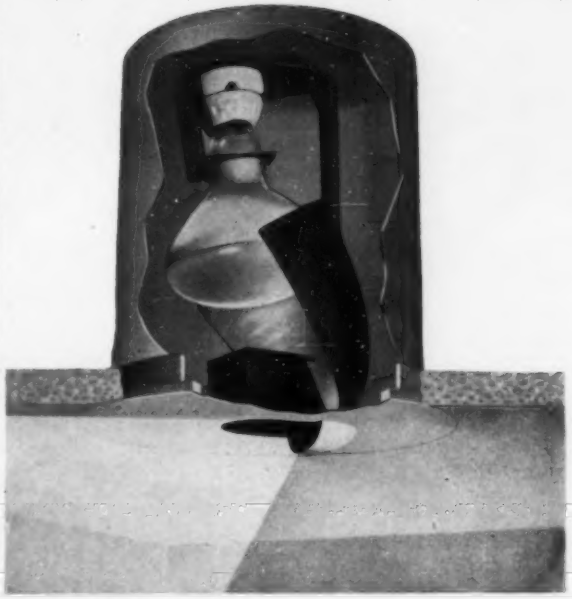
That is, if it isn't the Third Edition (with the big 3 on the backbone) published in 1959.

Special offer, one copy at $7.50, registered in I.E.S. members' name, still applies. Otherwise $10.

Bring your information up to the minute.

Order from:

Publications Office
ILLUMINATING ENGINEERING SOCIETY
345 E. 47th St. New York 17, N. Y.



Wall Washer Downlights with Designed Optics by Kliegl
. . . the Great Name in Lighting!

Designed optics . . . controlled wall lighting from an inconspicuous overhead light source. A specially shaped Alzak finished reflector was created for Kliegl Wall Washer Downlights. This unit, with its uniquely shaped reflector, permits the use of a pinhole aperture and produces a soft overall light pattern without annoying hot spots or scallops.

Kliegl Wall Washers are optically designed to correctly illuminate *any* wall whether it is blank or decorated with pictures, murals or tapestries.

Plan to use Kliegl Wall Washer Downlights in your next project. In the meantime, for complete information, write for our Architectural Lighting Catalog.

lighting
KLIEGL BROS.
UNIVERSAL ELECTRIC STAGE LIGHTING CO., INC.
321 W. 50th ST., NEW YORK 19, N.Y.
ORIGINATORS AND MANUFACTURERS OF KLIEGLIGHTS

THE KEY TO BRIGHTER LOCKS...

Markland Locks and Dam on the Ohio River.

THOMPSON servisafe POLES

Safe navigation through the busy Markland Locks on the Ohio River depends on the skill of experienced river pilots and bright uniform illumination. That's why Thompson Servisafe poles were specified by the engineers who designed the installation. As the lights are lowered, they are automatically disconnected. Maintenance personnel can replace burned-out bulbs and service fixtures on the ground . . . quickly and with complete safety.

Request full details on specs, installation and costs.

THE THOMPSON ELECTRIC COMPANY
P. O. BOX 873-K
CLEVELAND 22, OHIO

INDEX TO ADVERTISERS
August 1961

Advance Transformer Co.	1A
Aerovox Corp.	34A
Alexander-Tagg Industries Inc.	43A
American Louver Co.	Inside Back Cover
Benjamin Div., Thomas Industries Inc.	22A-23A
Certified Ballast Manufacturers	26A
Cirvac Plastics	42A
Corning Glass Works	29A
Crouse-Hinds Co.	30A
Day-Brite Lighting Inc.	4A-5A
General Electric Co., Apparatus Div.	25A
Edwin F. Guth Co.	Back Cover
Hexcel Products Inc.	2A
Kliegl Bros.	43A
Kopp Glass Inc.	21A
Litecontrol Corp.	6A
Meierjohan-Wengler	42A
Mitchell Lighting Div., Compco Corp.	41A
NL Corp.	43A
Pyle-National Co.	15A
Revere Electric Mfg. Co.	8A
Sechrist Mfg. Co.	41A
J. H. Spaulding Co.	18A-19A
Sylvania Electric Products Inc.	37A
Texas Instruments Inc., Metals & Controls Div.	40A
Thompson Electric Co.	44A
Union Carbide Plastics Co., Div. of Union Carbide Corp.	39A
Union Metal Mfg. Co.	10A
Wakefield Corp.	Inside Front Cover
J. A. Wilson Lighting	33A

AVAILABLE NOW!

NOW FOR THE FIRST TIME IN HISTORY

2½ x 5 FT. LOUVER PANEL

Luxury lighting at definitely lower installation costs. Designed for today's popular 10 x 10 building module, American's new 30 x 60" louver is readily adaptable to any module.

Now you can offer your customers more lighting . . . better lighting . . . with substantial savings in installation costs! With American's new and exclusive 2½x5-ft. louvers, less structural work is needed because each louver covers a larger area than others providing larger areas of uninterrupted light.

These oversize louvers are of sturdy, deep-cell styrene construction and present 45° x 45° shielding. With less structural work and supporting trim needed, they're ideal for continuous runs and offer a wide variety of installation patterns. Specify American's new 2½x5-ft. louvers for suspended ceilings, in particular . . . in new or remodeled construction. Here's the modern glare-free way to adequately illuminate large areas at lower cost than ever before thought possible!

Other louver sizes—
1 foot x 4 feet •
2 feet x 4 feet in
42° - 45° and 55°
Shielding.

PLEASE SEND FREE SAMPLE KIT

NAME

FIRM

ADDRESS

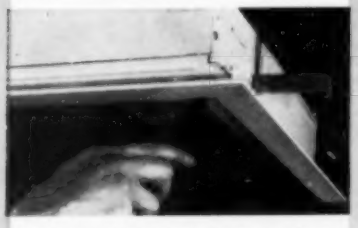
CITY ZONE STATE

american louver company

5308 NORTH ELSTON AVENUE
CHICAGO 30, ILLINOIS

GUTH saves up to 50% on Troffer installation*

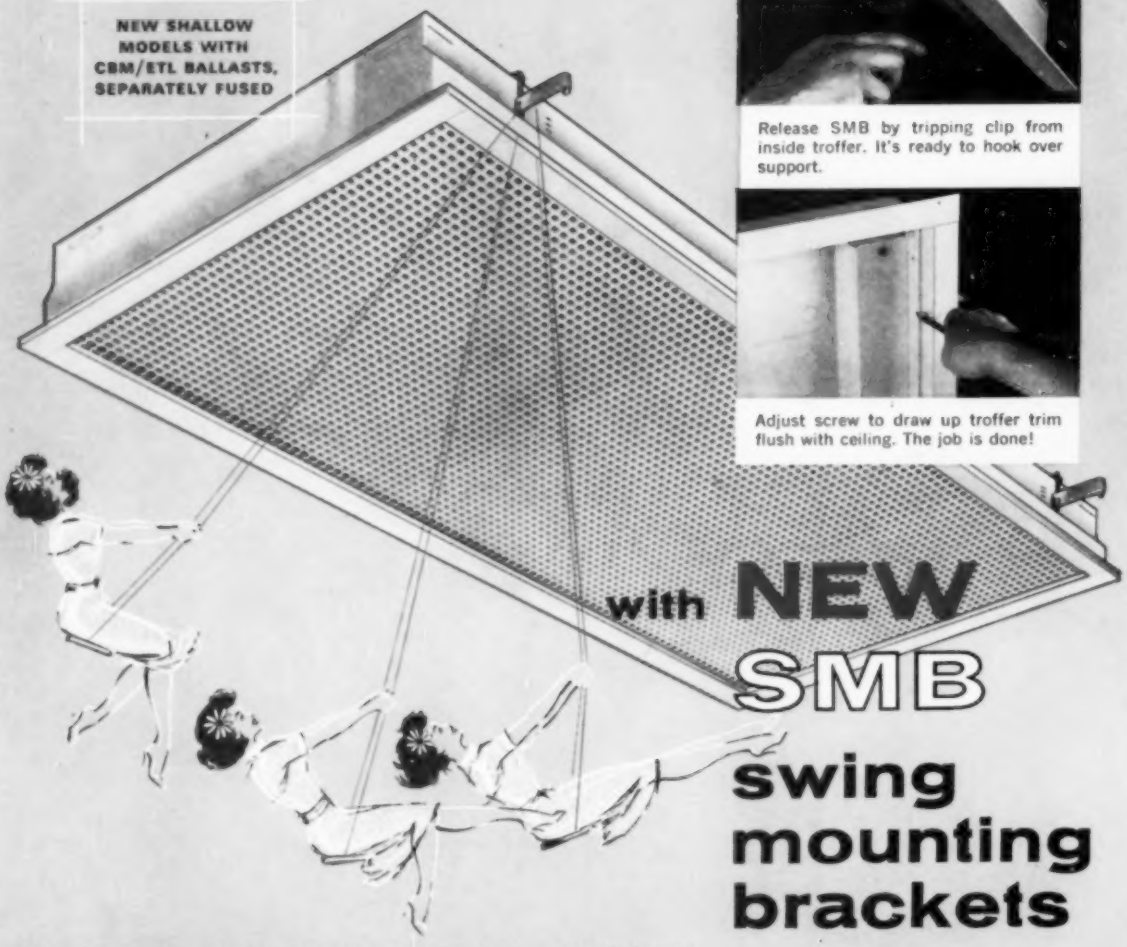
Swing Mounting Bracket is preset for height of ceiling support members by adjusting single screw.



Release SMB by tripping clip from inside troffer. It's ready to hook over support.

Adjust screw to draw up troffer trim flush with ceiling. The job is done!

NEW SHALLOW MODELS WITH CBM/ETL BALLASTS, SEPARATELY FUSED



with NEW SMB swing mounting brackets

New Guth Troffers feature Swing Mounting Brackets to simplify installation...**plus** a complete variety to fit most every specification requirement!

New 4¾" shallow models come in 2' and 4' widths. Other units in 6" and 12" widths . . . 2', 4' and 8' lengths. Almost any bottom you can name — including GrateLite Louver Diffuser°° and Prismoid GrateLite†. Adaptable to nearly every type of ceiling suspension system.

*These savings do not include wiring and final connections and are based on installation in a plaster or concealed suspension system.

ASK FOR GUTH SMB TROFFER BULLETINS!

THE EDWIN F. GUTH CO. 2615 WASHINGTON BLVD. • BOX 7079, ST. LOUIS 77, MO.

Guth LIGHTING since 1902

°°U. S. PAT. NO. 2,740,001 CAN. PAT. NO. 536,240 †U. S. PAT. NO. 2,904,673